MODERN COLOR

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CAMBRIDGE

HARVARD UNIVERSITY PRESS

LONDON: HUMPHREY MILFORD

OXFORD UNIVERSITY PRESS

1923

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Chapter I

THE IMPORTANCE OF A COLOR TECHNIQUE

THE aim of this book is to explain in a simple and compact way a method of painting color. It is a method now being used with great success by a number of artists, and it is so easy of mastery and so mechanically accurate that it seems a pity it should not be shared with all artists. The method has nothing to do with a man's style of painting and is adaptable to any style that undertakes to paint light as it is. The art student spends a great deal of time in the schools learning how to draw accurately, how to copy exactly the shape of

an object before him. When the student leaves the school he may for one reason or another modify what he has learned there or disregard it, but he will do this not through ignorance but in order to obtain some other end. And the fact that the artist does know what good drawing is will show all through his work no matter how much he may apparently disregard it. It will save him at least from making unnecessary blunders. Every artist no matter what his style may turn out to be, even a cubist, perhaps most of all a cubist, ought to know how to draw accurately.

In the same way every artist ought to know how to paint light accurately. Every artist ought to know how to get exactly the correct highlight, and exactly the correct shadow. He ought to know just what to do when the light is made more intense or less intense, or when the model is moved from studio light into sunlight. He ought to know how to get exactly the correct color for his reflected lights, how to look for these and how to control them. It is a method for doing just these things that we are going to explain in this book.

But are not these things taught in the schools? Yes, in some degree lately but with a deficient technique. It is astonishing how false the eye plays one in matters of color. A student in a prominent art school was paint-

ing a model with red hair. He put in the proper reddish yellow for the local color of the hair, raised the color to a tint for the highlight, and lowered it to a shade for the shadow. But it looked dull and lifeless. Yet he had painted it as nearly as he could as he saw it. When the master came round, the student complained of the effect. "It is rather tame, is n't it?" said the master, and taking a brush he filled it with violet and touched up the shadows here and there. The hair immediately leaped into vitality. "How did you know that was the thing to do?" asked the student. "Only by experience," was the reply.

"Only by experience." That is just the trouble. When the student comes to paint red hair again, he will know what to do. But what will he do to obtain the same vitality in black hair and golden hair and white hair? He must find a separate rule for each. That means trying and trying again, scraping with the palette knife and trying again. The colors will inevitably go muddy and the artist's spontaneity will be gone. There is no one simple rule that can be applied. Each change of lighting, and each slight alteration of color, creates a new problem that has to be solved anew. When is one to make cold shadows, is a question students are constantly asking, and the only answer has been, experience. In all

these matters the young art student is left totally without guide or support.

But why not copy the colors as they are, copy the highlights and copy the shadows as you see them, just as the draftsman copies the shape of a muscle as he sees it? Because none but mature artists, and not all of these, see shadows and highlights as they are. A man can see almost any color in a shadow or a highlight if he sets about it. There has been a common saying that in ordinary studio lighting all highlights are blue from the reflection of the sky, and there is not a bit of doubt that many artists filled with this theory actually see all the highlights in a studio blue. But there is no theory more false. The only way for a highlight in studio lighting to be blue from the reflection of the sky is to place the model so near the window that the light of the sky shines directly down upon her. The student I just spoke of tried to paint the highlights and shadows on the hair just as he saw them, and undoubtedly he did paint them as he saw them, but he did not paint them as they were. It is only with years of experience and close observation that men see colors as they are, and there are some men probably so constituted that they can never see colors as they are. Their painting of light is consequently a sort of loose guesswork, and if their

pictures are of merit it is for other reasons than their light effects.

The technique we are going to explain is nothing but a simple mechanical method of finding out accurately what the colors of shadows and highlights really are, and of painting a picture consistent with its lighting. It is well known by most artists at present that the shadow of a color is not only darker than a color but generally also of a different hue. The shadow of ultramarine blue, for instance, is not only darker but more violet; the shadow of cyan blue is not only darker but greener. And there is no rule by which one can tell what direction a color will turn as it grows darker or whether it will turn at all. The same is true of the highlights of a color. In other words the highlight of a color is rarely the same as its tint, and the shadow of a color is rarely the same as its shade. Indeed, there are many artists who never realized there was this distinction between shade and shadow, and between tint and highlight. But as we shall see in a subsequent chapter, the recognition of this distinction and the application of it to painting are the very soul of the illusion of light in a picture. It is making this distinction clear together with the psychological impossibility of an art student being able to see what the color of a highlight or a shadow really is that makes the

technique so valuable. Even mature artists of long experience have had their eyes opened by some of the facts this simple technique brings out.

There are five main advantages an art student may derive from this technique. First, he will be able to paint an object with exactly the colors the object has in real existence. As just said, it is impossible for an art student by any mental strain to see those colors just as they are. But in this technique an indirect method is used which gives the artist exactly the color of the object. Painting the object in that color, the artist will be astonished with the effect of reality and luminosity he will obtain in his picture. The artist will have reproduced accurately the colors and light effects on the object just as an able draftsman reproduces exactly the shape of his model. The first advantage of this technique, then, is that it makes easily possible — that is, as easily as good draftsmanship is possible — a true representation of light.

A second advantage is that it makes possible a perfect consistency of light effect throughout a picture. Many pictures otherwise admirable are marred by an inconsistent treatment of light in different parts of the same picture. The head will appear to be in a soft illumination and the rest of the picture in a bright light. We

look at the picture and feel that something is wrong but do not know just what. When the inconsistency is not great it is especially difficult to find where the trouble lies, and yet the picture is lacking in a force it might easily have attained. Or again, part of a picture may be painted in a cold light and part in a warm light and there will be no discoverable reason for the sudden change. These faults are very easy to fall into when an artist is trying to copy his object color for color. But by the use of this technique it would be utterly impossible for an artist to make such mistakes.

A third advantage is that since by this method an artist can know at the start precisely what each shadow and highlight in his picture will be, he has one less obstacle in his way, and his spontaneity is by that much the less restrained. When an artist has to work for each shadow he makes, work and fail and scrape and try again, he is bound to lose some of his freshness and freedom, and the labor he is forced to employ will be somewhat reflected in his picture.

And a fourth advantage follows right out of this one. Since the artist knows to begin with what the right color is, and does not have to repaint, each color he puts on can stand as he puts it on. The colors will be pure and there will not be any muddiness.

The fifth advantage is for those artists who paint in large masses of color. These artists have always had to meet a dilemma. If they wished to keep the sense of solidity in their pictures, they had to break up their masses of color with shadows and highlights. On the other hand, if they wished to keep the whole effect of large masses of color, they had to sacrifice solidity. Now, with this technique that dilemma largely dissolves. For it turns out that the reason shadows and highlights broke up color masses was that they were not painted as they really were. If a blue shawl is spread over a model's shoulders, and part of it is in shadow and part of it is not, the shawl still counts in real life for a single mass of blue. In real life we ignore the shadow and feel the shawl to be of one uniform color. Now, if that shadow is painted in the picture exactly as it is in real life, we will do the same thing in the picture, ignore the shadow and see the shawl in the picture as of one uniform color. But yet since the shadow on the shawl is correctly represented in the picture, we feel the form under the shawl also. In other words, the artist obtains both a feeling of solidity and a feeling of one uniform mass of color. And the means by which he does this is by using a technique that gives the shadow exactly as it is, not one jot different this way or that.

Now this technique, as will be discovered when it is described, will seem rather mechanical and the rules for using it rather dogmatic. Unfortunately that seems to be the only way of describing a technique so that it can be easily understood and followed. An artist need not follow this technique step by step as it is described. Each artist may find a way of modifying it that for him brings better results. But so long as the principle at the bottom of it is understood, any number of modifications may be made safely. And many artists may become sufficiently expert to do away with the mechanical side of the principle altogether and obtain results exactly as accurate.

But the chief thing to remember about this technique is that like any other technique it does not commit an artist to any one style of art. An artist ought to know how to paint light accurately just as he ought to know how to draw shapes accurately. Each is a valuable, almost a necessary, thing to know whatever the school an artist may choose to belong to.

Chapter 2

SOME GENERAL FACTS ABOUT COLOR

BEFORE explaining the technique in detail it seems advisable to mention a few of the principal facts about color that underlie any discussion of the subject. Most of these facts are well known to the majority of artists, but there is no harm in repeating them here and it may save misunderstanding later.

Color is a sensation. It is due to ether vibrations striking nerve endings in the retina of the eye, which transmit the impulses to the brain, whereupon we receive the sensation of color. Strictly speaking, we ought not to call anything color but a sensation. But for con-

venience we often give the name of color to the ether vibrations that correspond to the sensations. And as a matter of fact when we use the word, color, in this book we shall more often mean the ether vibrations than the sensations. But it must never be forgotten that ether vibrations would be nothing at all to painting if they did not ultimately bring about sensations.

Ether vibrations of different wave lengths correspond to colors of different hues. The wave length of red is about 685 millionths of a millimeter, of green about 525, of violet which has the shortest wave length about 390. Every hue of color has an ether wave length corresponding to it, and these wave lengths have been worked out many times very carefully by physicists.

Now, a ray of white light is a stream of ether vibrations containing many wave lengths. Just what those wave lengths are can always be discovered by passing the ray through a prism. What the prism does is to cause these waves to turn a corner, and it makes the short waves turn much farther than the long ones. The result is what is called a spectrum. The short violet waves are forced to make a big turn, the longer green waves do not have to turn so far, and the very long red waves only have to turn a little distance. Consequently, the violet rays will be way over on one side,

the red rays way over on the other, and the green rays somewhere between. This turning of a ray of light is called dispersion and is one of the principal phenomena of light.

Another important phenomenon is reflection. If a ray of light strikes a smooth shiny surface, it rebounds; and that surface becomes itself a source of light. We are so familiar with this action in a mirror that it does not need any explanation. A third important phenomenon of light is absorption. If a ray of light is shot into a deep hole, it does not seem to have any effect. We can see this by looking into a deep hole in the day time. Just as much light from the sun goes down into the well as onto the ground about the well, but that which goes down into the well never comes back. It is totally absorbed.

Absorption and reflection are very important from the artist's standpoint, for they explain the great proportion of colors that we see about us indoors and out. In the day time practically the only source of light is the sun. Suppose we call sunlight white for the moment. (Sunlight really is not always white, as we shall see later, but we will call it white for the moment.) Now, if every object in nature reflected all its light and sunlight were white, it is evident that every object in nature would be white. Grass would be white, and houses, and

fences, and the ocean, and the sky. Everything would be white, because everything would be returning by reflection all the light it received from the sun. On the other hand, if every object in nature absorbed all the light it received, everything would be black, and except for a white sun shining in a black sky the world might as well be plunged in utter darkness. But since the objects in the world about us are neither all white nor all black, it is apparent that they must reflect some of the light they receive and absorb the rest.

It is this difference among objects in the amount of light they absorb and reflect that makes the variety of color in the things we see. An object like grass that absorbs nearly all the light except the green light, we call a green object, because green is the only light that comes back to us. A red poppy absorbs nearly all the light that comes to it except the red. That is reflected, so we call it red. And so with all the objects about us. A gray object is one that absorbs an even proportion of all the colors that come to it and reflects an even proportion. All objects in nature absorb some light and reflect some. The most dazzling white snow absorbs some light and the blackest of velvets reflects a little.

Now, the pigments that an artist uses to paint with are in no respect different from most of the common ob-

jects we see about us in the way they give out color. A pigment is simply a substance that can be conveniently applied to surfaces with a brush. And a blue pigment is simply such a substance so constituted that it absorbs most of the light that comes to it except the blue light. The blue it reflects, and consequently when it is applied to a surface the surface appears blue. Furthermore, pigments contain many imperfections. The brightest pigments absorb a great deal of light, even more than a large proportion of the objects about us; and the darkest pigments reflect a lot of light. The range of pigment colors is consequently much narrower than the range of colors in nature. This forces an artist to make some sort of compromise. For if an artist wishes to paint a landscape, he will find many objects before him brighter than any of his pigments, and some objects darker. How to meet this problem is one of the great technical difficulties before an artist. It is a problem we shall have to deal with later.

Another imperfection in pigments is that like nearly all substances that absorb and reflect light, they do not reflect a pure light. A pigment that reflects red reflects other colors too, but it reflects so much red that we cannot see the other colors in it. Nevertheless those other colors show up the moment the pigment is mixed with

another pigment. The mixing of pigments, consequently, becomes a problem all in itself that has no relation to the mixing of lights. This is a very important point to bear in mind. A mixture of pigments is an entirely different thing from a mixture of lights. The most conspicuous example of this is the mixture of blue and yellow. Mix blue paint with yellow paint and it comes out green, but mix a ray of blue light with a ray of yellow light and it comes out gray or white. The reason is that a blue pigment reflects a good deal of green light along with the blue, though not sufficient to be seen while the pigment is unmixed, and similarly a yellow pigment reflects a good deal of green light. The result is that when these pigments are mixed together, the blue pigment absorbs the yellow light and the yellow pigment absorbs the blue light, but the green light reflected by these pigments is not absorbed by either, but on the contrary intensified by the mixture and the total result is consequently green. Few mixtures of pigments act the same as mixtures of light. A mixture of orange cadmium and ultramarine blue in pigments makes green, while in light it makes a pinky violet; and a mixture of vermilion and dark blue in pigments makes a dull reddish violet, while in light it makes bright purple. And so it goes. From mixing pigments an artist cannot

obtain the remotest idea of what happens when lights are mixed. Yet it is light that an artist paints and mixtures of lights. It is hardly necessary to emphasize this fact nowadays, but it is a fact that cannot be too often repeated. A picture is an artist's representation of light. An artist should, therefore, above all understand the nature and behavior of light.

What are the characteristics of light, or color, and how are these related? Color has three primary characteristics — hue, value, and saturation. By hue is meant whether a color is red or yellow or blue. By value is meant whether a color is light or dark. Pink is a higher value of red; dark red a lower value. High values of a color are often called its tints, low values its shades. Tints are usually thought of as above the spectrum value of a hue, shades as below it. By saturation is meant the amount of gray there is in a color, whether the color is pure or neutral. A red may be of the same hue as spectrum red, and of the same value as spectrum red, but be grayer. We say it has a different saturation. The purer a color and the nearer it approaches the spectrum colors, the greater its saturation. The grayer and more neutral a color, the less its saturation.

It is possible to see roughly how these different characteristics are related to each other by representing

them in a figure. On this page is a double cone. The upper apex represents white, the lower apex black. The circumference of the plane at which the two cones meet represents the spectrum hues. Circling the cone one passes through the series of hues. Going up or down the axis of the cone from black to white one passes through the series of grays. Going from the periphery of the cone in towards the axis one passes through the series of saturations. The reason the plane at which the two cones meet is tipped is that the values of the various spectrum hues is different. Yellow is the lightest of the spectrum hues and violet the darkest.[1]

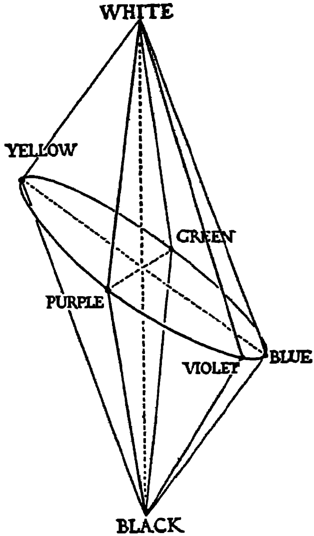


FIG. I

[1] The reader must pardon the figure for not accurately representing this fact. According to the figure blue would be darker than violet. But we wished the figure to remain true to the main facts of color mixture and at the same time to be simple enough for a student's ready comprehension; and truth to some details had to be sacrificed in the process.

The relation of the various characteristics to one another can now be easily seen. Some of these relations are a little surprising. For instance, it appears that hues are at their highest saturation at about middle value. Consequently, if in a given illumination you take a spectrum hue and make it lighter, it must inevitably grow grayer also. That a spectrum hue made darker should become grayer seems natural, but many people are surprised to learn that if a spectrum hue is made lighter in a given illumination the same is true.

The cone gives also in a rough way what are the results of a mixture of lights. There are three laws of light mixture. First, for every hue another hue can be found which when mixed with the first in the right proportions gives gray or white. Such colors are said to be complementaries. Examples of complementary colors are red and blue-green, orange and green-blue, yellow and blue, yellow-green and violet, green and purple. (Red was once thought to be the complement of green, but that is now known to be false.) These hues will be found opposite each other on the color cone, so that if a line were drawn from one to the other it would pass through gray, the axis of the cone. The proportions of the hues to be used to make gray depend on various factors and have to be discovered by experiment. But once the critical

proportions are found, then if there is an excess of one of these complementaries in the light mixture, the result will be a grayish color of the hue that is in excess. For example, if there is too much yellow in a mixture of blue and yellow to give gray, the result will be a dull yellow. If a line is drawn in the color cone from one to the other of the two colors to be mixed, the result will always be found somewhere on that line depending on the proportions used.

The second law of color mixture states that if two colors are mixed that are not complementaries, the result will be a color that is midway between these two. Thus a mixture of blue and green gives blue-green, a mixture of red and yellow gives orange, and a mixture of red and green gives yellow. The proportions to be used will depend on the values and saturations of the colors mixed. But the approximate result can be found by drawing a line in the color cone between the two colors to be mixed. The result will lie somewhere along that line.

The third law states that when two mixtures of identical color are mixed, the result will be the same color. Thus, if a gray made by a mixture of blue and yellow is mixed with a gray made by a mixture of red and blue-green, the result will still be gray. This may seem too obvious to require a law but it is not self-evident.

All these facts are very important, and the simplest way to keep them clearly in mind is to see them through the color cone. For in a rough way the color cone shows the relations of all the various colors to one another, and summarizes the laws of color mixture.

But there is still another set of facts that artists ought to understand thoroughly. That is the facts of color contrast. Take a piece of blue paper and put it on a gray background and look at it for a full minute. Then snatch the blue paper away. In the place where the blue paper was will appear a spot of yellow exactly the size and shape of the blue paper that was snatched away. If the paper is green, the spot will be purple. If the paper is orange, the spot will be green-blue. The spot that follows after the paper has been taken away is called the after image, and the phenomenon is known as successive contrast. In every case it will be found that the after image is the complement of the color of the paper.

But a phenomenon even more important for an artist to know is that of simultaneous contrast. If we take the blue paper again and put it on the gray background and after looking at it a short time allow our attention to stray to the edge of the paper, we shall see a ring of yellow on the gray all round the blue paper. This is

simultaneous contrast. Every color especially if saturated will cause its complement to appear round it.

Now, suppose this blue paper had been placed on a background of some other color besides gray, what would have happened then? Suppose it had been placed on a red ground. Then there would be a ring of orange round the blue. Why? Because according to the laws of light mixture red and yellow make orange, and the yellow ring which the blue paper causes to appear mixes with the red of the ground and produces orange. Consequently, the ring about the blue paper is orange. But there is more than this to it. The ground will also make its complement on the blue paper. The complement of red is blue-green. Consequently, the blue paper will appear greener than it is.

But what would happen if the blue paper were placed on a yellow ground? Why, then the yellow which is the complement of the blue spreading over the yellow of the ground would make the yellow still yellower, and the blue which is the complement of the yellow would spread over the blue of the paper and make the blue still bluer, so that the saturation of both colors would be much increased.

What result simultaneous contrast will have upon two colors brought together can always be discovered by

finding out what the complements of the colors are and seeing how the complements of each color will mix according to the laws of light mixture with the neighboring color. Suppose it is purple and orange that we are thinking of combining. The complement of purple is green. The complement of orange is green-blue. According to the laws of light mixture the green mixing with the orange will make it yellower and grayer; and the green-blue mixing with the purple will make it bluer and grayer. Each color will in some degree drive the other away from it and kill it (i. e., reduce its saturation, for when we speak of one color killing another what we mean is that one color takes the saturation out of the other). We could work out the result for any pair of colors in the same way.

And if we worked out the results for all the pairs of colors, we should find that the nearer together two colors are on the color cone the more they tend to kill each other in combination; and that the further apart two colors are the more they assist each other in combination, and the maximum effect of saturation comes from combining a pair of complementaries. How important these facts are for the painting of light, quite apart from all aesthetic considerations, we shall discover later. They are so important that Cutler's scale, which

we will describe presently, is based on the principle of contrast in spite of certain disadvantages that entails.

These facts about color contrast are important not only for showing the artist what to do but also what not to do. Hasty inferences from these facts have led artists into all sorts of strange practices and theories. For example, some artists think it necessary to paint the effect of contrast on the picture. There was a still-life of yellow flowers exhibited lately by a very able modern artist in which he painted a blue ring on the background behind the flowers. This blue ring he apparently meant to represent the halo of blue which would appear about the yellow flowers by contrast. It gave a most curious appearance to the picture, and was entirely unnecessary, and rightly considered untrue. For as a matter of fact, the yellow pigment with which the flowers were painted would throw a ring of blue on the background by the force of its own contrast. To paint the blue contrast in, therefore, exaggerates to a point of absurdity a point that if left alone would take care of itself.

And there is a whole theory of painting based on a similar misunderstanding about contrast. It is the theory that a shadow should be painted with the complement of the color of an object in illumination. This theory has had great vogue in landscape painting be-

cause the sun being yellow and the reflection of the sky in the shadows being blue, the theory seems to find corroboration. But it is the reflection of the sky that makes the strong blue in the shadows, not contrast. And the appearance of the complement in the shadows in this case is not corroboration but coincidence. There is, of course, foundation for the theory. The complement of a color *tends* to appear in the shadows. But if it does not appear strongly, and if the artist paints it in the shadow, he will be exaggerating and distorting nature. And the result is rarely so luminous as if he paid attention to other things and allowed contrast to take care of itself. It will take care of itself if the true colors of light and shadow are painted. The painted light will throw its complement on the painted shadow.

These warnings must not be taken to mean that the principles of contrast are unimportant. They are exceedingly important — one of the most important factors for the painting of luminosity — but they have been misapplied by artists in many cases. The greater the need, therefore, for a thorough understanding of the nature of contrast.

A great deal of talk has been made first and last about so-called primary colors, and there is a good deal of misunderstanding as to what they mean. Primary colors

are simply certain colors chosen because for one purpose or another they are more important than other colors. They are always chosen with reference to some purpose. Three sets are well known. One set is the psychological primaries — red, yellow, green, and blue. The purpose underlying this set was to pick out those colors that did not show any trace of other colors in them. There is a red that does not have any blue in it nor any yellow. There is a yellow that does not have any green nor any red in it. Going through the colors in this way, the psychologist finds that red, yellow, green, and blue are the only colors that have no ingredient of other colors in them. The average artist will hesitate to admit green among these, because he thinks he sees yellow and blue in it. But that is because he is so used to mixing yellow and blue pigments to make green that he invariably thinks of these two colors when green is seen. As a matter of fact green is as simple as red or yellow.

Another set of primaries comes from physics. They are the primaries of light. They are red, green, and blue-violet. There is a touch of yellow in the red and a touch of blue in the green. The purpose for which these primaries were chosen was to find the least number of colored lights out of which all other colored lights could be made at the highest saturation. Almost any three

colored lights if they are far enough apart from each other in the spectrum will give all other colors by mixture. But these three give all the others at their highest saturation.

The third set of primaries every artist knows. They are the pigment primaries, red, yellow, and blue, out of which all other pigment colors can theoretically be made by mixture. The purpose underlying this set of primaries was to find a set of pigments from which all other pigment colors could be derived by mixture.

There is nothing wonderful or mystical about primaries. They are simply colors chosen for a certain purpose. So much error and confusion has arisen out of them that sometimes it seems as though the artist would be better off if he had never heard of their existence. But for the purposes of this book, which is to explain a way of painting light, and in which color means light rather than pigment, it is advisable to keep the light primaries in mind and forget the others. Since light is what we are interested in, we shall consider red, green, and blue-violet to be the primaries.

These are the principal facts about color that are presupposed in what follows. And the most important fact of all that overshadows all the others and must be kept continually before the mind if the book is not to be com-

pletely misunderstood, is that the color we are dealing with is light, not pigment. It is light we are painting, and pigment is only the imperfect medium which for the lack of anything better we have to use for the painting of light.

Chapter 3

CUTLER'S COLOR SCALE

THE outstanding purpose of a color scale is to systematize color, to map it out so that an artist will not be blindly wandering through a forest of hues, but will know where he is and how to get from one place to another. It must not be imagined that a color scale is anything like a musical scale. A musical scale becomes a part of a musical composition, which is built up on a system of tonality imbedded in the piece. A color scale never appears in a picture and a person who looks at a picture never has to know that one was used. In dealing with color scales it is best to forget all about the exist-

ence of music and its scales. Such points of resemblance as there are only serve to confuse the artist. The great purpose of a color scale is to systematize and map out color.

Now, just as there are many kinds of maps each with its drawbacks and advantages — since it is impossible to remain true to all the relations when a spherical surface is being represented on the single plane of a sheet of paper — in the same way there are many color scales each with its drawbacks and advantages. Consequently, in making a scale one must decide what for his purposes is the most important thing for a scale to remain true to. For our purposes, for the purpose of painting light, one of the most important things to know about a color is, what is its complement. And it happens that if we remain true to this, we shall also remain true to the shadows and highlights of a color, which are even more important to know in the painting of light. As these are the essential things to know for our purposes, Cutler has developed his scale on the basis of complementary colors. And the success that attends this scale in the actual practice of painting light confirms the principle on which it is based.

In making this scale and in all of Cutler's technique of painting light, a color top has to be used. One can be

purchased for a few cents at a kindergarten store. The top is simply a heavy one that will spin for several seconds and has an arrangement by which disks can be placed upon it. But the best apparatus is an electrical wheel run by a dry battery. The apparatus costs a couple of dollars and can be obtained at almost any electrical supply store. The purpose of the top or wheel is to furnish a means of mixing lights. If a disk is painted partly blue and partly yellow in the proper proportions, and placed on a top and spun, it will appear gray. The top spins so fast that the rays reflected from the two colors on the disk mix in the eye, and we obtain a result exactly the same as if we looked at a ray of blue light mixed directly with a ray of yellow light. The top mixes light. And something that will do this for us we must have since it is light that we are painting. There are other means of mixing light besides the top, but none so simple and convenient for the artist. So the first thing to do is to purchase a color top or wheel.

Perhaps this is the best point to explain how with least trouble to the artist the wheel can be used to obtain mixtures of colored lights in different proportions. Suppose the artist wishes to discover what proportions of blue and yellow spun on the wheel make pure gray. One method would be to take a single disk and paint it

part yellow and part blue, and spin it and watch the result. Suppose he paints it half yellow and half blue. When it is spun the color will be yellow gray. That shows there is too great a proportion of yellow. To change the proportions he must paint an entirely new disk. Sometimes in using this method he would have to

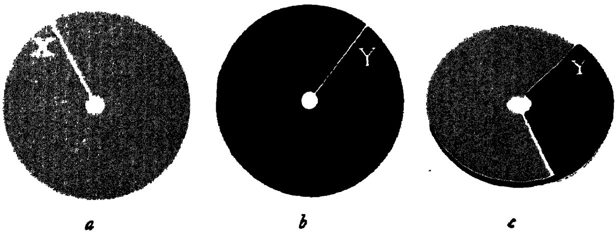


FIG. 2

paint eight or ten disks before he reached the correct proportion.

To obviate this trouble the artist will often find it better to employ not one disk but two, in the following way: Let him take the two disks and paint one all yellow and the other all blue, and allow them to stand till they dry. Then let him cut a slit from the edge to the center of each disk as shown in figure 2*a* and 2*b*. Now, if he takes flap X on the yellow disk and pushes it down, and takes flap Y on the blue disk and lifts it up; then by bringing the blue disk under the yellow disk so that their centers

are together, he can slip flap Y right over flap X as shown in figure 2*c*. Then he can change the proportions of his colors by merely pushing more or less of the blue flap over the yellow flap. And the two disks can be put on the top and spun together. Not only two disks but

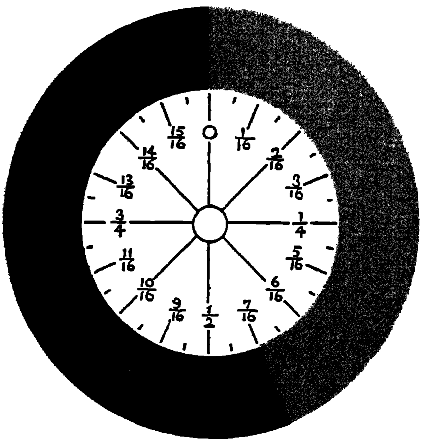


FIG. 3

three or four can be used simultaneously in this way. The disadvantage of this method is that the disks have to dry before they can be slipped over one another, and that takes time in oils. But this method requires much less labor on the part of the artist than the single disk method and is much more accurate.

An artist may be puzzled as to how best to measure exact proportions of color on a color wheel. A good way is to construct a measuring disk. The artist cuts out a disk somewhat smaller in diameter than the disks on which the colors are painted,—enough smaller so that the edges of the color disks will project a convenient distance beyond the edge of this disk, which is to be the measuring disk (cf. fig. 3). Then he can geometrically divide the measuring disk into equal parts. Two diameters at right angles will divide the disk into quarters. These right angles bisected will divide it into sixteenths. These last angles bisected will divide it into sixty-fourths. An artist with a ruler and a pair of compasses can make these divisions in a few minutes and mark them distinctly on the edge of the disk.

Now all the artist has to do to get his proportions of colors is to lay his measuring disk on the color wheel over the color disks, and by the marks on the measuring disk to divide the color disks to whatever angle will give him the proportions he wants. For instance, suppose he wants a proportion of 7/16ths yellow to 9/16ths blue. He takes his two slit color disks of yellow and blue and slips one over the other in such a way that the exposed part of the yellow makes an angle of 7/16ths as measured by the measuring disk. The exposed portion of

the blue disk will then cover 9/16ths of the circle, and the artist will have obtained the proportion he wanted. (cf. fig. 3.)

At first a man will find experimenting on the color wheel somewhat difficult. But with a little practice he will be able to obtain the results he wants after a very few tests. It is simply a matter of practice, and like all such things requires a certain amount of patience at the beginning.

If we know how to use the color wheel, we can proceed to construct Cutler's scale. The scale consists of eight series of colors. The main series consists of twenty-four hues at the highest saturation that pigments can give. It is the nearest approximation to the spectrum colors that can be obtained in pigments. Then there are three series of highlights with twenty-four hues in each series, these twenty-four corresponding to the twenty-four in the main series. Then there are three series of shadows with twenty-four hues in each series corresponding to the twenty-four hues in the main series. And lastly, there is a short series of five grays with pigment black at one end and pigment white at the other. The three series of highlights are distributed at equal intervals of value between the main series and pigment white. The three series of shadows are distributed at equal intervals

of value between the main series and pigment black. With the exception of the series of grays, each of these series is derived from the main series which is the parent of the whole scale. The main series, therefore, is the fundamental one in the scale. The way the main series is constructed is this: First lay out on the palette the following colors in the order given: —

English vermilion
cadmium red
orange cadmium
cadmium deep
cadmium
aureolin
zinc yellow
strontian
lemon yellow
emerald green
vert emeraud
cerulean blue
cobalt
new blue
artificial ultramarine
mineral violet, or any bright violet
cobalt violet
rose madder

White and black will also be needed. These are the pigments out of which by mixture the main series of the scale is constructed. Some of them such as emerald green are fugitive, as the artist knows, and should not be

used in painting a picture. But the colors in this list are chosen because they give the most saturated colors that pigments can give. If for any reason one of these pigments cannot be obtained, the artist should put in its place the nearest approach to it he can find.

We have all these pigments laid out on the palette in the proper order. Next, we cut out twenty-four cardboard slips, one for each color in the series. These we number from one to twenty-four, and as we obtain each color in pigments we shall paint it on its proper slip.

Cutler begins the construction of his scale with the three light (i. e., physical) primaries. These, it will be remembered, were red, green, and violet-blue. A very close approximation in pigments to the red primary is English vermilion straight from the tube, and to the green primary emerald green straight from the tube. The approximation to the violet-blue primary cannot be so easily obtained. Artificial ultramarine is the basis for the color, but taken straight from the tube its value is too low. Correction for the value is made as follows: Black and white disks are combined in the proportion 3/64ths white to 61/64ths black. When these are spun they give the value of the violet-blue primary. We, therefore, raise artificial ultramarine taken straight from the tube to the value of these disks when spun together.

We raise the value of the pigment, artificial ultramarine, by adding white pigment to it. That gives us the pigment approximation to the violet-blue primary.

In the completed series the primaries are Nos. 1, 9, and 17. Hence we take cardboard slips numbered 1, 9, and 17; and paint 1 with English vermilion, 9 with emerald green, and 17 with artificial ultramarine raised to the correct value in the manner shown.

From these three colors and one other the rest of the scale can be derived mechanically. That one other color is the complement of the violet-blue (i. e., of No. 17, the artificial ultramarine corrected as above shown). The next step, therefore, is to obtain the complement of No. 17. That has to be done on the color top and the way it is done is this: From our acquaintance with color we know that the complement of violet-blue lies somewhere among the yellow-greens. It lies somewhere between English vermilion (No. 1) and emerald green (No. 9). As a matter of fact, it has been discovered that if an English vermilion disk is spun with an emerald green disk in the proportion of half and half, the light mixture that results is very nearly the hue of the complement of violet-blue (No. 17). It will not be exactly the right hue, but it will be so nearly right that a little adjustment will make it so.

In getting the complement of No. 17, therefore, the first thing we do is to take a slit disk painted with English vermilion (No. 1) and another painted with emerald green (No. 9), spin them together in the proportion of 1/2 and 1/2, and observe the hue they make. That hue we shall find lies somewhere near aureolin. We match that hue in pigments by a mixture of aureolin, zinc yellow, and vert emeraud. (The value of the mixture should be that of black and white disks spun together in the proportion 7/16ths white to 9/16ths black.) The saturation made by the mixture of these colors will be stronger than that of the color on the top, but that is what we want. We match in pigments only the hue of the color on the top; we ignore its value and its saturation (both of which are too low). It is only the hue of the color on the top we are looking at.

Now we take a new slit disk and paint it with our yellow-green mixture of aureolin, zinc yellow, and vert emeraud. Then we spin that disk on the color wheel in combination with the violet-blue disk (No. 17) and adjust the proportions to get as near pure gray as possible. If on spinning these disks the resulting gray is somewhat violet-blue, that means we have too large a proportion of violet-blue; if the gray is yellow-green, that means we have too large a proportion of yellow-green. But if after

all our adjustments the gray still remains impure, we know that our yellow-green mixture with which we painted one of the disks is wrong. Suppose the nearest approach to pure gray is more yellow than the yellow-green we mixed, that shows we need more zinc yellow in the mixture. We mix in a little more zinc yellow in the mixture, and paint a new disk with the new mixture. We spin this in combination with the violet-blue disk (No. 17) as before, adjusting the proportions to get as near pure gray as possible. Suppose this time the gray is greener than the new yellow-green mixture. That shows we have too much zinc yellow and need a little more aureolin in our mixture. We put in a little more aureolin, and paint a new disk and spin that in combination with the violet-blue disk (No. 17). We continue making adjustments in this manner until we obtain on the top a gray that has no suggestion of any hue in it, such a gray as is obtained by mixing black and white on the color wheel.

When we get such a gray, we know we have a pair of complementaries. And when we get a yellow-green mixture that makes such a gray with the violet-blue, we have the color we want, the complement of violet-blue. That color is No. 5 in Cutler's scale; so, we take cardboard slip No. 5 and paint it with the color of our correct yellow-green mixture.

Now we have Nos. 1, 5, 9, and 17 of Cutler's scale. From these four colors the rest of the scale can be derived mechanically on the color wheel. We paint slit disks with these four colors and spin them on the color wheel in the various proportions given below. The light mixtures so obtained will be the remaining colors of the main series of Cutler's scale. The proportions are as follows: —

(Ver = English vermilion = No. 1
GY = greenish yellow = No. 5
G = emerald green = No. 9
VB = violet-blue = No. 17)

1.	Ver		13.	G 4/8	VB 4/8
2.	Ver 6/8	GY 2/8	14.	G 3/8	VB 5/8
3.	Ver 4/8	GY 4/8	15.	G 2/8	VB 6/8
4.	Ver 2/8	GY 6/8	16.	G 1/8	VB 7/8
5.	GY		17.	VB	
6.	GY 6/8	G 2/8	18.	VB 7/8	Ver 1/8
7.	GY 4/8	G 4/8	19.	VB 6/8	Ver 2/8
8.	GY 2/8	G 6/8	20.	VB 5/8	Ver 3/8
9.	G		21.	VB 4/8	Ver 4/8
10.	G 7/8	VB 1/8	22.	VB 3/8	Ver 5/8
11.	G 6/8	VB 2/8	23.	VB 2/8	Ver 6/8
12.	G 5/8	VB 3/8	24.	VB 1/8	Ver 7/8

As each of these colors is spun up in the proportions stated, it is matched as nearly as possible in pigment and the cardboard slip of the proper number is painted with that pigment. If the artist uses the pigments listed

on page 37, he will be able to match the spun colors fairly closely. But in some cases there will be a certain discrepancy, the spun colors being on the whole a little more saturated than the nearest attainable pigment mixtures. Since the colors on the cardboard slips are the ones employed by the artist in practice, it is probably best to regard these as the standard scale, and the spun colors as merely a means for obtaining that scale. In other words, Cutler's scale is not the scale of spun colors but the scale on the cardboard slips. Apart from standardization, however, this distinction is negligible: that is, for all of an artist's practical purposes, the pigment scale can be regarded as identical with the spun scale.

Now we have the main series of Cutler's scale complete. It is based on the three light primaries, Nos. 1, 9, and 17. No. 5 (GY) is derived from No. 17 (VB) being its complement, and the other colors of the main series are derived from these four. It is not possible to derive No. 5 from Nos. 1 and 9 directly because the light mixture of these two is so low in value. The purpose of No. 5 is to give vitality to the yellows so that they will have the same relation to the other colors of the scale that the spectrum yellows have to the other colors of the spectrum.

Indeed, when the colors of the main series of Cutler's

scale are laid out in order, we have about as near a representation of the spectrum as pigments can give. The colors are at the highest saturation possible in pigments, and the other peculiarities of the spectrum follow. The yellows are highest in value, the violets lowest. To be exact, No. 5 is the color in the scale highest in value, No. 17 the one lowest in value. Nos. 19 to 23 are purples, and, of course, are not to be found in the spectrum.

The physical primaries, Nos. 1, 9, and 17, it will be found have the highest saturations of any colors in the series, and their complements, 13, 21, and 5, the lowest. Consequently, when the scale is stretched out and seen as a whole, it presents a sort of festoon effect with the physical primaries prominent and their complements retired — a characteristic that gives a certain variety and beauty to the scale itself.

One of the most remarkable features of the scale is that though it is mechanically constructed, every hue in the main series has its exact complement somewhere else in the series. To find the complement of a color in this scale, add twelve to the low numbers or subtract it from the high ones. The complement of 3, for instance, is 15; of 8, it is 20. On the other hand, the complement of 17 is 5, and the complement of 23 is 11. The artist will find it

useful to put down on each cardboard slip not only the number of the color painted on it but also the number of its complement. This fact that every color in the scale has its complement is a convenient check on the construction of the scale. If, for instance, a pure gray cannot be obtained by a mixture of 23 and 11 on the color wheel, we know that these two colors have not been accurately derived.

It is not claimed that the series of colors just described is an ideally perfect scale, but only that the series is one about as well adapted to the artist's medium as can be obtained. Oil medium is by no means perfect, and the scale has to be tempered to the limited capacity of the medium. We have at our command in oil few if any permanent and brilliant violets; the blue-greens are muddy; the yellows high and thin. There is nothing approaching a good range of uniformly saturated colors. Even in selecting the four disks to construct the series just described, we are hampered by the limitations of the oil medium. The English vermilion is most nearly true. But the green-yellow is rather gray, there being no low yellows of much transparency besides the earth colors. The emerald green and violet-blue are also somewhat gray. Aside from English vermilion they are all weaker in saturation than we should wish. Nevertheless, the

hue in each case is correct, and the mixtures resulting on the wheel come pretty well within the range of the artist's palette.

But even here there are discrepancies, since, as we said a moment ago, some of the mixtures we get on the wheel cannot be exactly copied in oil pigment. The series of violets (Nos. 18 to 24) produced by spinning together the vermilion and violet-blue disks are rather more saturated than any corresponding violets that can be obtained from oil pigments. In the series of spun colors from Nos. 10 to 16 we can match the bright blues in oil pigment but not the vivid blue-greens. Nos. 6, 7, and 8 can be pretty well matched. And for 2, 3, and 4 there are actually pigments brighter than the spun colors. But on the whole the scale completed in pigments is less lively than the scale spun on the wheel: all of which merely goes to prove what the artist already knows too well, how limited and restricted are the capacities of the oil medium.

But if we admit these limitations, this scale is about as perfect as can be obtained. The main series as just described is a measured circle of vivid hues, well balanced, well graded, and fairly evenly saturated. It is for oil colors what the spectrum is for all colors. It is the spectrum, the rainbow, brought down out of the skies to

earth where men can use it. Like all wild things brought into captivity, this also loses some of its lustre. But the spectrum has never been of any use to artists in its splendor among the clouds, being too brilliant, too far beyond men's reach; while this scale may be of inestimable use. Its very limitations to the capacities of pigments are what make it useful. For it has been constructed with the artist's problems continually in view and with the intention of lessening some of these problems so as to release the artist's energy for the better solution of others.

Having obtained the main series of the scale, we can obtain the series of highlights and shadows comparatively easily. There are three series of highlights above the main series, it was stated. Let us call these series highlight series I, highlight series II, and highlight series III. Highlight series II is of a value midway between that of the main series and pigment white.[1] Highlight series I is of a value midway between that of the

[1] This does not imply, of course, that all the colors of highlight series II are of the same value, but only that the plane of the values of highlight series II is midway between the plane of the values of the main series and pigment white. As just remarked, p. 44, the yellows of the main series are highest in value and the violets lowest, so that the plane of values of the main series tips from yellow down to violet. All the highlight and shadow series of the scale will, consequently, show a similar tip in their planes of values.

main series and that of highlight series II. Highlight series III is of a value midway between that of highlight series II and pigment white.

By experiment it has been found that if disks are spun in the proportion 1/4th pigment white and 3/4ths the color of the main series, they will give a color of a value midway between pigment white and the color of the main series. That color will, therefore, be one of the colors in highlight series II. Consequently, all we have to do to obtain the twenty-four colors of highlight series II is to take each color of the main series and mix it on the color wheel with 1/4th of a disk of pigment white. For instance, to get the color in highlight series II that corresponds to No. 9 (emerald green) in the main series, we spin an emerald green disk with a pigment white disk in the proportion 3/4ths emerald green to 1/4th white. That will give the color corresponding to No. 9 in highlight series II. We take a cardboard slip marked II, 9 and paint this color on that slip. We do the same with all the other colors in the main series, and that gives us highlight series II.

Now, it has also been found that 1/16th of pigment white with 15/16ths of the color of the main series spun on the top gives a value midway between the main series and highlight series II. And that is just the value

we want for highlight series I. Consequently, all we have to do to get the twenty-four colors of highlight series I is to take each color of the main series and mix it on the color wheel with 1/16th of a disk of pigment white.

It has also been found that 9/16ths of white with 7/16ths of the color of the main series gives a value midway between highlight series II and pigment white. And that is just what we want for highlight series III. Consequently, to get the twenty-four colors of highlight series III, we take each color of the main series and mix it on the color top with 9/16ths of a disk of pigment white.[1]

Now we have the three series of highlights. Corresponding to these are three series of shadows. Let us call them shadow series I, shadow series II, and shadow series III. Shadow series II is of a value midway between that of the main series and pigment black. Shadow series I is of a value midway between that of shadow series II and pigment black. Shadow series III is of a value midway between that of shadow series II and that of the main series. Now, the proportions used for the highlights apply equally well to the shadow series. A proportion of 3/4ths pigment black and 1/4th

[1] Cf. Appendix I.

the color of the main series spun on the top gives the corresponding color of shadow series II. A proportion of 7/16ths pigment black and 9/16ths the color of the main series spun on the top gives the corresponding color of shadow series III. And a proportion of 15/16ths black and 1/16th the color of the main series spun on the top gives the corresponding color of shadow series I.

In mixing the pigment colors of the highlight and shadow series, pigments straight from the tube should be used as much as possible, for the addition of pigment white or black to another pigment reduces the saturation of a color out of all proportion to the value. White is as bad as black in this respect. One must be particularly careful in the shadow series, however, otherwise the colors will lack vitality and be muddy and disagreeable. There are many earth colors that can be used to get the low values of a hue. Unless there is special reason for it, black should be seldom employed in a pigment mixture except as a last resort.

There remains only the series of grays, five colors running from black to white and including black and white. These are obtained by the same proportions we have just used. Pigment black and pigment white stand at the two extremes of the series. Middle gray is

obtained by mixing 1/4th white with 3/4ths black on the color wheel; high gray by mixing 9/16ths white with 7/16ths black; low gray by mixing 1/16th white with 15/16ths black.

Now we have Cutler's scale complete — a main series of high saturations, three series of highlights, three series of shadows, and a series of grays. Let us examine the scale a little more closely and see what are its peculiarities.

The structure of the scale, it will be seen, is symmetrical, and it is based on groups of fives. There are five values in the series of grays, there are five values from pigment black to the main series through the series of shadows, there are five values from the main series to pigment white through the series of highlights, and the main series itself is divided into groups of five. For the framework of the main series is the three light primaries and their complements — Nos. 1, 5, 9, 13, 17, and 21. These are the extremes of six groups of five. There are five colors from 1 to 5, five from 5 to 9, five from 9 to 13, and so on. Not that there is anything mystical about the number five but it gives the scale a certain symmetry to be based on a number like this, and that is a valuable quality for a scale to have if nothing is lost thereby. And nothing is lost.

But it may be said that there are no unsaturated series in this scale except the series of grays. That is true and it is often desirable to have series of unsaturated colors, for saturated colors are not the only beautiful ones. Cutler recognizes this and has constructed a number of unsaturated series consistent with his scale. But these unsaturated series should be regarded rather as additions to the scale than as fundamental to it. The series of shadows and highlights were derived from the main series. But the various series of low saturations are derived from the shadows or highlights. The series of low saturations are therefore twice removed from the main series. We take highlight series II, for example, and obtain three shadow series from it just as if it were the main series, these series being at regular value intervals between pigment black and the value of highlight series II. For instance, to get a No. 9 in a series of low saturations and of a value midway between pigment black and highlight series II, we take the 9 of highlight series II and mix it on the color top with 3/4ths of a disk of pigment black. That will give the low saturated 9 we want. And that 9 will be the actual shadow of the 9 in highlight series II and will be the complement of every 21 in the scale no matter in what series it may lie. What we have done with 9 we do with

every other color in highlight series II, and that will give us a complete series of twenty-four colors of low saturation and of a value midway between pigment black and the value of highlight series II. By using the proportions 7/16ths to 9/16ths and 1/16th to 15/16ths, two more shadow series of low saturation and of intermediate values can be made all in true shadow relation to highlight series II. And it is evident that similar low saturated shadow series can be made from other highlight series. Also low saturated highlight series can be made from each series of high saturated shadows. And these low saturated series may be made the basis for still other lower saturated series, and so the scale may be continued to infinite complexity. As many low saturated series can be made in this manner as the artist desires. And the beauty of this scale is that if it is constructed on the principles laid down here, a 9 in any series whatever is the complement of every 21 no matter in what series the 21 may be, and no matter how many series have been constructed, or to what complexity the scale has been developed. Through and through the scale is true to the principle of complementary colors. But it is best for the artist when he begins not to bother with the unsaturated series. They are an added complexity and are likely to confuse rather than help

until the artist has the rationale of the scale well in mind.

But a thought that suggests itself to everyone is, Why call the upper and lower series highlights and shadows? Why not call them tints and shades? Because in most instances they are not tints and shades but are always quite literally highlights and shadows. What is a highlight? It is that point on an object that directly reflects a large amount of white light along with the natural color of the object. And that is exactly what we do on the disk to make the upper series of colors. We paint some white on the disk beside the color, so that when the disk is spun a quantity of white light is reflected with the color. And what is a shadow? It is the local color of the object placed in dimmer illumination. It is the local color reflecting less light than it did in full illumination. When we paint black on the disk for the lower series, we make the color do exactly the same thing. Black means merely that a very small amount of light is being reflected. Consequently, if black is spun with a color, what happens is that the color reflects less light than it did when spun alone. We therefore have in the upper and lower series of this scale exactly the conditions of highlights and shadows made on the main series.

The three series of shadows are as if weaker and

weaker light were thrown upon the main series, and that is exactly what heavier and heavier shadows are. And the three series of highlights are as if more and more white light were thrown upon the main series and that is exactly what brighter and brighter highlights are. In a fairly strong light (say, average studio light) an object of the local color of 5 in the main series would have its big shadow of the color of 5 in shadow series II. In a weaker light its shadow would have the color of 5 in shadow series III. And in an exceptionally strong light its shadow would be 5 in shadow series I. And the highlights would be 5 in some one of the highlight series depending on the illumination and the material painted. How valuable these facts are needs no demonstration.

But more than that, it is very rare that the highlights and shadows of a color are the same as its tints and shades. Just to take a few examples: The tint of pure yellow is light yellow, but the highlight of pure yellow is light orangè-yellow. The shade of pure yellow is dark yellow, but the shadow of pure yellow is olive green. Again, the tint of purple is light purple, but its highlight is light violet (i. e., bluer than the tint). And the shade of purple is dark purple, but its shadow is dark violet. Once in a great while shades and shadows coincide. For instance, the shadows of orange, Prussian

blue, violet, and carmine are the same as the shades of these hues. Once in a great while also tints and highlights coincide. The highlights of greenish yellow, and violet, are the same as their tints. The shade and tint of a color are always of identical hue; the shadow and highlight are rarely of identical hue. This distinction should be clearly understood by the art student, for on it chiefly depends an artist's power of producing the effect of light in a picture. Let us give parallel definitions of these four terms:

Tint is a higher value of a given color, the hue remaining constant — e. g., light yellow is the tint of yellow.

Shade is a darker value of a given color, the hue remaining constant — e. g., dark yellow is the shade of yellow.

Highlight is the addition of white light to a given color, the hue generally changing in consequence — e. g., light orange-yellow is the highlight of yellow.

Shadow is the diminishing of light on a given color, the hue generally changing in consequence — e. g., olive green is the shadow of yellow.

How little relation shades have to shadows and tints to highlights can be seen at a glance by looking at Cutler's scale when complete. It is one of the great values

of this scale that it informs the artist how the highlights and shadows go. And no rule will serve. Rules have been made but they apply about as well as rules of spelling apply to the English language. Sometimes shadows change hue from right to left, sometimes from left to right. Sometimes the highlight changes in the same direction as the shadow, sometimes in the opposite direction. And sometimes the change of hue is very great, and sometimes there is no change at all.[1] The easiest way to be sure what happens is to have the scale before one for reference.

An additional advantage in having the upper and lower series highlights and shadows instead of tints and shades is that by doing the former the scale still remains true to complementaries. The complementary of blue in shadow is not dark yellow but olive green. That is to say, if blue and the right olive green are spun together, they give pure dark gray. For the middle values the complement of blue is pure yellow, but for low values the complement of blue is yellow with a tinge of green in it. In other words, the complement of a color in low value is its shadow, not its shade. And wherever there is a change of hue as a color passes from light to shadow, there will also be a change of hue in a complementary.

[1] Cf. Appendix II.

Accordingly, a color may have two or three different hues as complementaries, the change of hues depending upon a change of values.

There is a simple way of demonstrating this. Take a pure saturated blue and look at it for a minute on a black ground. Then snatch the blue away. The after image on the black ground will be the olive green we speak of, which proves that olive green is the complement of blue in shadow. The black ground acts on the after image of blue exactly as a shadow would or any reduction of illumination. And similarly the complementary after image of blue on a white ground would be found to be light orange-yellow, which is the highlight of yellow. In other words, while the complement of blue is pure yellow for middle values, it is olive green for low values, and light orange-yellow for high values. These results could be corroborated on the color top. Every hue has a number of complementary colors depending on the value used. Cutler's scale remains true to this fact.

And this fact explains why there is frequently disagreement among artists as to just what the complement of a color is. The complement of yellow is generally called pure blue, and it is pure blue at middle and low values. But there are some artists who say there is a little violet in it. And that also is true. The complement

of yellow for high values is a light violet-blue. All of these facts are exceedingly important for the painting of light and Cutler's scale is admirably suited to exhibit them.

A consequence, however, of making the upper and lower series highlights and shadows instead of tints and shades is that the intervals between the colors in these two sets of series is not the same as in the main series. To take one example, the shadow of pure green is a trifle blue. The shadow of blue-green is greener than blue-green. Consequently, the intervals between greens and blue-greens in the main series are much wider than those between the same colors in shadow. In fact, the intervals of all eight series of Cutler's scale differ slightly from one another. More than that, the intervals of the main series are not all the same. The blues, blue-greens, and yellow-greens have much closer intervals than the yellows, reds, and violets. But this is unavoidable. If a scale is to be based on the principle of complementary colors as Cutler's scale is, its intervals cannot be all of the same length. A scale with consistently equal intervals throughout cannot remain true to complementary colors, and for the purposes of painting light it is more essential to know the complement of every color than to have all the intervals regular.

But all these criticisms aside, it will be asked, Does not Cutler's scale restrict the freedom of an artist who paints with it? Will it not make his pictures mechanical and artificial? In answer to this question we must reply in all candidness that if used without imagination or breadth of view, it probably would. There are many sides to art. There are many sides even to the painting of light. And the man who has mastered all of these sides will find many ways of tempering one with another. But a man must master these different sides one by one first. Just now we are interested in the particular and very important problem of the effect of light and shade on color. And this scale and the technique to be described in the next chapter are probably the best instruments for the solution of that problem yet discovered in art. It is, consequently, our business to describe these two instruments in their simplest (and therefore narrowest) form. And the student will probably find it is best also to acquire the mastery of these two instruments in their simplest form. When each has been mastered, then the ultimate application of them will be a different matter. And artists will undoubtedly vary according to their personality as to how closely they cling to the normal scale. To make ourselves clear, however, on this point, and to bring out a few other

points which we are not ready to consider yet, we shall set aside a subsequent chapter for the explanation of the wider applications of the scale.

What are the uses of this color scale? First, it systematizes color — a virtue which, of course, all color scales possess. Color with its infinite variety constitutes a universe in itself and even an artist is liable to lose himself in it if he does not have it mapped out and organized in some way.

Secondly, it is an inspiration to the artist. This also is true of all color scales. If an artist is set adrift in the universe of color, he is likely to float into some comfortable and often very beautiful group of colors and spend the rest of his life among them. How many an artist we know whose pictures invariably turn up with the same little combination of colors. He drifted into that combination once by chance and has stayed with it ever since. He does not know what colors there are. He has never traveled among colors. Now, a color scale like this saves a man from such narrowness, and saves his pictures from a color monotony. Just to have this scale round the studio, to watch the chance combinations that occur, is a stimulus. With the purples, and blues and greens of this scale strewn over a table, a man could not possibly spend all of his life painting in yellow

ochres and pinks. Yet we know men that do. More than that, with all these series of highly saturated colors (because with the exception of the series of low saturations nearly all these colors are at the highest saturation pigments can give) it would be impossible for an artist to paint always in dull grays. Once in a while he would have to bring life into his picture with a saturated color. The colors of this scale are particularly good for their liveliness and freedom from muddiness. One of the uses of this scale is as an inspiration to artists for brilliance and variety of coloring.

The third use of this scale is that it tells the artist at a glance what the complement of every color is. One who has not tried to paint light cannot realize the importance of this information. It is particularly needed when sunlight is painted. Take two or three of the most saturated colors one can find in the studio — if Cutler's scale has been prepared, take two or three of the colors of the main series — and put them in the sunlight. What happens? They do not grow whiter, they grow more saturated. If a color is the strongest red one can find in the studio, it is still redder in the brilliant illumination of sunshine. It is a common mistake in painting an object part in sunshine and part in indoor illumination, to paint the part in indoor illumination as

strong as pigment can paint it (supposing the object to be of a strong color); then the part of the object in sunshine will be painted as if it were a highlight by adding white to the strong color. The effect will be missed entirely. A streak of sunlight falling across an object is not a highlight at all. A highlight is the direct reflection of white along with that of the local color. But a streak of sunlight on an object is simply a strong illumination of the local color. The color is not so much made lighter as many times more saturated. What the artist should do in a case like this is to paint that part of the object in sunshine with the most saturated colors he can find and then treat the part of the object in indoor illumination as if it were in shadow (which it is).

The moral of this is that for the ordinary illumination that we have indoors or out, the greater the illumination the more saturated the colors. Now a picture is always to be seen indoors. Consequently, the greatest saturation that an artist can count on is the saturation of his pigments under indoor light. That saturation is low compared with many objects we see about us indoors; it is very low compared with the saturation of outdoor objects. It follows, therefore, that if an artist wishes to obtain the effect of brilliant illumination, he must use his colors at the highest saturation that he can get.

There is just one way that an artist can make his pigments more saturated than they are on his palette. That is by combining them with their complements in the picture. If two complementary colors are placed in fairly large masses side by side, each color gains in saturation.

The fourth use of this scale is that it gives the artist the correct shadow and highlight for every color of the main series, and for every color of the other series also if the various low saturated series have been constructed. That means the artist can completely change the color scheme on his model, painting her dress the color he chooses, not the color it happens to be; and yet he will know exactly what the light would do to the color he chooses to paint the model's dress if the model were wearing that color. He does not have to take his colors from the model's clothes; he can take his colors from the scale and the scale will tell him what to do with them, what should be their shadows, and with care what should be their highlights. There will, of course, be a number of facts about light and illumination that he must know besides, but the big main facts lie in the scale.

That is to say, with a sufficient foundation of knowledge an artist is able to paint a luminous picture with

the use of the scale alone and in almost total disregard of the model except as an object to be drawn. Not only the colors but the degree of illumination can be governed from the scale. If shadow series I is used for the principal shadows of the colors chosen, the model will appear to be in brilliant illumination. If shadow series II is used, she will appear to be in moderate illumination. An artist can control his illumination by the consistent use of any shadow series he determines upon. Particular care, however, must be taken with the highlights and other details, as we shall see later. But the essential facts for painting light lie in the scale itself, and can be educed from the scale almost in disregard of the model painted. The scale is not only a guide but actually a tool for painting light.

Cutler's scale, then, is valuable in that it systematizes color for the artist, is an inspiration to him for obtaining variety and vivacity of color, gives him the complementaries of every color, a knowledge of which is valuable for many of the more brilliant effects of luminosity, and it gives him the relation of every color to its shadows and highlights so that he can paint a color truly even when it is not present before him.

For all these reasons this scale is of great assistance to an artist. It is not a necessity. Cutler's technique for

painting light does not presuppose it. Rather the scale presupposes the technique. Also an artist need not have this identical scale before him, in order to benefit from all its advantages, so long as he has one like it, one based on the principle of complementary colors. For one reason or another an artist may find it convenient to modify this one. He may prefer to have fewer or more colors in each series. He may wish to add to the number of series. He may wish to start from other colors than the physical primaries. Some of these changes might be an improvement over this scale, though any such innovations should be balanced against one extraordinary advantage of this scale, the fact that it can be accurately and easily derived mechanically. But the great thing from the point of view of the artist who wishes some technical aid for the painting of light is that the scale should be built as this scale is on the principle of complementary colors. If it is built on that principle, it will do the work wanted of it pretty much irrespective of differences of detail.

Chapter 4

PAINTING IN STUDIO LIGHT
(CUTLER'S TECHNIQUE)

To understand the technique of painting light it is best to take the simplest problem first. The simplest problem an artist can have in painting light is that of painting a model in good studio illumination. If there is nothing shiny on the model nor in the setting such as bright metals, silks, or starched materials, and if there is nothing absorbent of light like velvet, then the problem is the simplest possible. Under such conditions an artist can obtain an exact match in pigments for every hue, value, and saturation of color before him. Shiny objects

if white are generally of a higher value in the highlights than pigment can match. Pigment white placed beside the highlight on a white starched collar or white satin seems gray in comparison. And when shiny objects are not white their saturation is often greater than pigments can match; there is no pigment so saturated as bright silk. On the other hand, pigment black seems light compared to black velvet. And there are sometimes deep shadows in the studio of which the same is true. Highly reflective and highly absorbent objects, therefore, we shall put to one side for the moment. They raise special problems that will have to be dealt with later. These objects aside, every object in studio lighting can be matched color for color.

We will also keep the model in the full illumination of the window, for there are certain peculiarities of low illumination that would complicate the problem. And we will also see that there are no strong reflected lights. If these conditions are complied with, it is evident that we have the simplest possible situation that could be created for the painting of light. There is no color before the artist that cannot be exactly matched with his pigments nor is the model in any abnormal illumination. There are, consequently, no value or saturation adjustments to be made, nor does the artist have to deal with

the perplexities of an unusual lighting. Everything is reduced to its simplest terms so far as light is concerned. Now let us see how the technique is employed in this simple situation.

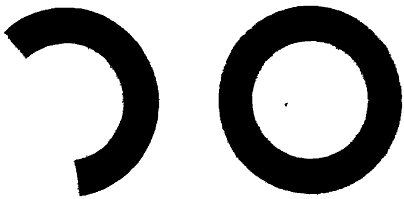
Suppose we have decided that the color scheme shall be yellow and blue with the pink of the flesh tint and the orange of reddish hair. This is not a startling color scheme, though a very luminous one. The flesh tint we must have. The orange of the hair is about what a mixture of the red hue of the flesh with yellow would make (thus avoiding the addition of a totally unallied color). Yellow and blue are complementaries. The model has on a blue dress and there is a yellow curtain behind her.

Now, the most important thing in a portrait is the face. We shall begin, therefore, with the lighting on the model's face. The first thing to determine is the local color of the flesh. The local color of the flesh is its color in full illumination excluding all accidents. Highlights will be counted as accidents, and shadows, also all little discolorations, moles and the color of blood vessels showing through. Notice especially that highlights are accidents. Nobody would ever take a shadow for the local color in studio lighting, but there is danger that if the highlights cover a large area, as they sometimes do when an object is seen at a certain angle, these will be

taken for the local color. Pictures have been painted under this illusion. The result is that they are not only untrue to the lighting but chalky and weak, because a highlight by its very nature is low in saturation. Consequently, if a highlight is taken for the local color, the real local color will be taken for the half-tone and its saturation will be brought down to that of the highlight, and all the force and truth of lighting will have gone out of the picture. That is to say, if the highlight is taken for the local color, the real local color and the shadows will all come out too gray. So, we must be careful not to confuse the highlight with the local color. The highlight is an accident. But the local color of the flesh is the color it has in full illumination when all accidents have been excluded.

We copy that local color in pigment on the palette. The next most important thing to determine is the shadow on the flesh. Since the model is in the full illumination of studio lighting, there will probably be (apart from gradations) only one half-tone and the deep shadow. We will obtain the deep shadow next. The way to do that is to paint a disk with the color of the flesh tone, leaving room enough on the edge of the disk for a strip of black in the manner shown in figure 4*a*. Now we spin the disk. There will appear a small circle

of the local color of the flesh in the middle of the disk, surrounded by a darker band of that same flesh color, as in figure 4*b*. The darker band is the light mixture of the local color of the flesh with black. Now we notice the difference in value between the flesh tint in the middle of the disk and the dark color that appears at the edge of the disk. We see if that difference in value is the same as



a. Disk Stationary *b.* Disk Spinning

FIG. 4

that between the color of the model's flesh in full illumination and the color of the model's flesh in dark shadow. If the color at the edge of the disk is too dark, we wipe away some of the black and put the local color of the flesh in its place. We experiment until the difference in value between the two colors on the spun disk seems the same as the difference in value between the color of the flesh in full illumination on the model and the color of the flesh in shadow. When these value relations seem the same, the color at the edge of the spun

disk will be the color of the deep shadow on the flesh of the model. It will be the exact color, and the art student, to say nothing of mature painters, could never in the world have got it by trying to copy the shadow directly. But if we now match on our palette the color we see on the edge of our top when it is spun, we shall have our shadow color ready for use at once and absolutely accurate.

Next we get our half-tone. We get this in the same way. We paint a disk with the local color of the flesh tint, leaving space on the edge for a strip of black. The strip of black will not be so long this time, as the half-tone is not so dark as the deep shadow. But having made an estimate of the amount of black necessary to produce the value of the half-tone, we spin the top. Once more we experiment putting on more black or more flesh tint, until the dark color at the edge of the disk exactly matches in value the half-tone on the flesh of the model. When the match is made, the color at the edge of the disk is exactly the color of the half-tone on the model. We match that color on the edge of the disk in pigments on the palette.

It remains to obtain the color of the highlight on the flesh. Once more we paint a disk with the local color of the flesh, leaving space at the edge this time for white.

It will not take much white. But we make an estimate. Then we spin the disk on the top. The color at the edge of the disk will this time be lighter than the color in the middle, since we have mixed white light with it. We look to see if this light color at the edge of the disk is of the same value as the highlight on the flesh. If it still seems darker than the highlight, we add a little more white to the edge of the disk. If it seems lighter than the highlight, we wipe out some of the white and put the local color in its place. We experiment in this way back and forth until the value of the color at the edge of the disk appears exactly the same as the value of the highlight on the flesh. When these values are the same, the color at the edge of the disk when that is spun will be exactly the color of the highlight on the flesh. We match this color with pigments on the palette.

Now we have mixed on the palette the local color of the flesh, the color of its half-tone, its deep shadow, and its highlight. So far as the flesh is concerned we could begin at once to paint with complete assurance that each color we put on was exactly what it should be for highlight, shadow, and half-tone. But it is advisable not to begin to paint until we have all our principal colors. The process from now on is extremely simple.

There are still the red hair, the blue dress, and the

yellow curtain. We must find the highlight, half-tone, and shadow for each of these. What we do first is to match the local color of each of these in pigments on the palette. Again we must be careful not to confuse the highlight with the local color, and if there are small stripes or polka dots in the goods, we must exclude these as accidents. Having obtained the local color of the hair, dress, and curtain, we proceed next to get the shadows of these. And the way we do that is this. We paint a disk with the local color of the hair, say. Then we take up the disk that gave us the dark shadow on the flesh, and see how much black we used on that disk to get that shadow. We put just the same amount of black on the new disk we have painted with the local color of the hair. That is, if we painted three-quarters of the old disk black for the dark shadow of the flesh, we paint three-quarters of the new disk black for the dark shadow on the hair. And we do not have to compare this color with the real shadow because we know it is correct.

For let us think, What is a shadow? It is a color in a dimmer light, dimmer because an object intervenes between the main source of illumination and cuts off some of the light that would otherwise have come to it. If we put black on the disk and spin the disk, what does that do? The black absorbs some of the light that would

have come from the color if the black were not there. That is to say, just as an intervening object takes away some of the light that would have come from a color on the model and makes a shadow, in the same way black takes away by absorption some of the light that would have come from the color on the disk and makes the equivalent of a shadow. And now, since the model is standing in a single illumination, it follows that the same amount of light must be taken away from all the objects in illumination to make their shadows. Consequently, if we take away the same amount of light from all the colors on our disks by adding the same amount of black to every disk, we shall get the equivalent of the real shadows for every color on them. In fact, so true is this that even if we did not succeed in matching the values of our shadows quite correctly in the first place, nevertheless by adding the same amount of black to every disk in making our subsequent shadows, we should give the impression in the picture of a consistent lighting, though not just the same lighting as that in which the model stood.

So, all we have to do to get all our other shadows, once the first shadow is obtained, is to put the same amount of black on every disk and mix it with the local color by spinning. Hence, to get the deep shadow for the model's

red hair, we paint a disk with the local color of the hair, put the same amount of black on the disk that we did on the old disk that gave us the shadow on the flesh, spin the new disk, and copy in pigments on the palette the color that appears on its edge. To get the half-tone on the hair we paint a new disk with the local color of the hair and put on the edge as much black as there was on the old disk that gave us the half-tone on the flesh. Then spinning the new disk we match the colors on its edge in pigments on the palette.

That gives us the half-tone and deep shadow on the hair besides its local color. By the same process we get the half-tones and deep shadows on the blue dress and yellow curtain. To get the highlights on the hair, dress, and curtain we cannot use the same quick method, because slight differences of texture make enormous differences in highlights where they make none in shadows. Consequently, to get the highlights on these objects, we have to spin them up on the disks in each case by mixing white to the required value with the local color, and in each case the required value of the highlight will be found different. The highlights on flesh and hair, for instance, will be of much higher value than those on dress and curtain, because the flesh and the hair are shinier, i. e., reflect more light.

When these are obtained, we have all the colors we need and can begin painting. All this is done before a brush is touched to the canvas. But when the artist does begin, he has not a thing to worry about so far as values or light effects are concerned. There on his palette lie the deep shadows, half-tones, highlights, and local colors of every object he is going to paint in his picture, and he knows before he begins that they are right and that they will look right and that as far as coloring goes his picture will be strong and luminous. The time that he would have spent in fussing over his values he can now spend on other things.

We now see the principle of Cutler's technique, and the question suggests itself, How is Cutler's technique related to his scale? It is evident that the scale is founded on the technique. The various series of highlights and shadows in the scale are spun up exactly as individual highlights and shadows are spun up in the technique. Consequently, if the technique happened to be dealing with a color that existed in the scale, the shadow and highlight of that color obtained by the technique might exactly match a shadow and highlight of that color in the scale—must match them if the intensity of light lands the shadow in one of the shadow series of the scale and the highlight in one of the highlight series.

Thus we see the relation between the scale and the technique. They amount to the same thing if they are dealing with the same colors and lights. Each, however, has its advantages. The advantage of the scale is that it can be used in the entire absence of the colors painted. The model may be standing in a dress of one color; the artist may paint it in an entirely different color, having chosen his color from the scale. And if he follows the highlights and shadows of the scale throughout the picture, he will obtain a powerful and luminous result. The disadvantages of the scale are that it restricts the painter to the colors that appear in the scale, and to the three degrees of illumination represented by the three series of shadows. He can paint with only twenty-four hues (unless he modifies the scale) and in only three illuminations. The advantages of the technique are that an artist can use any color whatever within the range of pigments, and can paint any degree of illumination. The disadvantage of the technique is that it cannot be used without the colors being actually before the artist when he is painting. The artist may use either the scale or the technique, whichever he sees fit.

But if the artist finds that for his type of painting, he always prefers the technique, he must not think that the

scale would have no value for him. As we saw before, the scale is valuable in many other ways besides being an actual tool for painting, and for its other uses the artist will find it advantageous to have the scale by him.

We have given in this chapter the essence of Cutler's technique. There are, to be sure, problems of detail like reflected lights and problems that arise when values extend beyond the limits of pigments, which we shall have to take up in the succeeding chapters. But the fundamentals of the technique have been given here.

Chapter 5

REFLECTED LIGHT

IN the last chapter we had the problem of painting light reduced to its simplest terms. The model painted was under a north studio light, she wore nothing shiny or highly absorbent that would have colors beyond the range that pigments could imitate, and she was put in a position where reflected lights were reduced to the minimum. Since all of these conditions are liable to be violated, it is necessary to take up one by one the special problems that confront an artist under situations different from that described in the last chapter. The next few chapters will be occupied with these various special

problems. The first of these, which we shall discuss in this chapter, is the problem of reflected light.

Artists as a whole have put too much emphasis on this subject. There is a common theory with an element of truth in it that every object in a room is a reflector sending out rays of light which necessarily strike every other object in the room. The model, therefore, is being illuminated by all these different rays of light. Consequently, on the model we shall find bits of blue light coming from all the blue objects in the room, bits of yellow light coming from all the yellow objects in the room, and bits of green light coming from all the green objects in the room, and so on. In other words, according to this theory, the model becomes a crude mirror reflecting to the eye all the objects there are in the room. It appears, then, by this theory that the most important thing for an artist to do is to paint these countless reflected lights coming off the model. Consequently, the painting of reflected light becomes the primary matter for an artist to attend to and all other things become secondary.

Now, while there is a certain amount of truth in this theory, it is a truth that would be of more interest to a physicist than to an artist. As a matter of fact, the theory has probably done much more harm than good to

art, for it has led artists to ascribe every little change of hue they observed on an object to reflected light, when in the great majority of cases it was due to something of a totally different nature. It has caused them to believe they saw reflected light where none could possibly be seen, it has blinded them to the true nature of lights they did see, and worst of all it has caused them to despair of any power of controlling the reflections for the aesthetic advantage of their pictures. And all of this is due to an imperfect knowledge of the manner in which reflected light actually does behave. It seems advisable, therefore, in order to avoid misunderstanding and perhaps to save the artist from falling into errors of his own making, to explain how reflected light behaves before showing how to paint it according to Cutler's technique.

And the first point to get well in mind is that reflected light is of entirely secondary importance in the painting of light effects. The matter of main importance is to have the relations of local color, highlight, and shadow correct. If these relations are correct, a luminous and true appearance will be brought out at once in the picture. The painting of reflected light is a refinement, something that will make the picture still more luminous and still more true, if correctly done, but not

essential for the painting of light. The great thing is to get the relations of light and shadow correct. If these are correct, the difference which reflected light makes can be easily attended to.

One of the mistakes that the theory just spoken of led artists to make was that of thinking that the illuminated surface of the model could show reflected light. Neither the main illuminated surface which gives the local color, much less the highlight, show any change to the eye due to reflected light. A little consideration will show why this is the case. A candle at night is very brilliant, but in the daytime we can scarcely tell that a candle is burning. What makes the difference? The sunlight is so strong compared with the candle light that it eats most of the candle light up, all but a little yellow streak not much brighter than the door knob. But at night all the room was reflecting the candle light, and we could see all the objects pretty clearly from the reflections of the candle light that they gave out. These objects must still be reflecting the candle light in the daytime. Why do we not see these reflections still? Because they are so weak beside the sunlight that they are completely eaten up.

Exactly the same is true of all reflected lights cast on the illuminated surface of a model. Such reflected lights

are necessarily weak. In order to be cast upon the illuminated surface most of them would have to be twice reflected, and every time light is reflected it loses some of its power. There is very little chance for any reflected light to survive visibly in the strength of a direct illumination. There is ordinarily no reflected light, therefore, in the highlights or illuminated surface of an object. If strange hues appear there, they are due to some other cause. On a model they may be due to discolorations of the flesh such as constant perspiration produces under the arm, or constant rubbing of the collar on the neck; or they may be due to blood vessels dimly showing through the skin; or again in the highlights they may be due to the regular change of hue which we have found takes place when a color is raised to its highlight. It would be curious to guess how many times this natural change of color when observed has been mistaken by artists for reflected light. There are many causes to bring in bits of foreign color to an illuminated surface, but reflected light is rarely one of them.

There are two exceptions. One is when the model is placed close to the window and the reflection from the blue sky shows clearly in the highlight. But in a case of this sort the model is being painted practically under a bluish illumination just as if there were a powerful blue

lamp in the sky shining down on the model. For all the light that comes in through a north window is sunlight reflected at least once; and if it all came down from a blue sky, it would all be blue, just as if the window were covered with a blue glass. As a matter of fact, however, a short distance away from the window the direct reflection of the blue sky is cut off, and the light from out of doors being reflected from all sorts of objects comes in white. But if a model is placed near a window, the blue light of the sky must be remembered.

A similar exception occurs when a model is illuminated with a strong light coming off a polished table or something similar. A bright mahogany table placed near a window with the model just behind it would throw up a strong glare of colored light on the model. It would then be as if the model were directly illuminated with colored light. In this case the reflected light off the shiny table is so strong that it makes itself felt even through the strong direct illumination. By the same principle an object in the dim illumination of the far corners of a room will also show reflected light on its illuminated surface provided the strength of the reflected light is relatively strong enough. But cases of this sort are rather rare and not apt to be found unless the artist deliberately plans them. It is a safe rule to

say that there is no reflected light on the illuminated surface of an object or in its highlights.

We may say, therefore, that the only place where reflected lights exist is in the shadows. But here again we must be careful not to mistake other things for reflected light. Changes of hue occur in the shadows naturally, as we have shown, merely as a result of reducing the intensity of light. These changes and the little alterations due to discoloration of the skin and the like must not be mistaken for reflected light.

Furthermore, in order to get reflected light, the shadowed surface must be a fair reflector. Velvets reflect practically no light under any circumstances, and unless the illumination is strong other materials reflect very little. The skin is a fair reflector. These different powers of reflection which different materials possess have to be watched with care by the artist, for it may well be that while there is reflected light in the shadow on a man's hand, there will be none in the shadow on his sleeve. These observations make a world of difference in giving the effect of texture to say nothing of giving that of luminosity. Even in shadows there is much less reflected light than would be expected.

It must also be remembered that the reflecting object — the object from which the reflected light comes —

must either be very large or very near, and in either case must be a good reflector. The lighter colored an object is or the more highly saturated in color the stronger will be its reflections; but a rough woolen goods even of pretty bright color can be brought very close to a shadow without making any perceptible difference. And even a shiny screen a few feet away from an object ceases to have any effect. It is often a matter of surprise to an artist how near a reflecting object must be brought to have any influence upon the lighting. If a piece of bright red silk is held close to the dark side of a model, all the shadows will be bathed in red. But if the silk is drawn away, the red will rapidly fade out of the shadows, and when the silk is a few feet off there will not be a trace of the red left in them. Many pictures are painted as if a strong reflected light were thrown upon the shadows, yet there will not be a sign of the cause anywhere near. Such a condition would be highly improbable. Worse still, a picture is sometimes painted with strong reflected light of one color falling on one part of the shadows and strong reflected light of another color falling on other shadows and with no sign of the cause at hand. To obtain such results the reflecting objects would have to be within a few inches of the shadows. All these little falsifications destroy the luminosity of a

picture. For while few people who look at such a picture will know what the matter is, they will feel that somehow that is not the kind of light they are used to seeing. From the point of view of luminosity it is better to leave out the reflected lights altogether than to make blunders of this kind.

The only reflected lights that can come from a distance must be from large uninterrupted surfaces that are fair reflectors such as walls and floors, and even from these the reflected light will be weak and will not show in the shadows on the model except where these come on smooth surfaces. Barring floors and walls the source of reflected light is certain to be quite near the object painted, if not on it. The great majority of reflecting objects will be found right on the model herself — the brim of her hat reflecting on her cheek, her shirt-waist reflecting on her arm, the folds of her dress reflecting back on her dress. So regularly is this the case that when reflected light is represented as coming from some source outside the picture, it is greatly to be suspected. For safety the artist ought to know the source of every reflected light he paints.

An easy way of finding out whether there is reflected light on a surface, and if so where it comes from, is to take a piece of white cloth and lay it over the shadowed

surface in question. If some color besides white appears on the cloth, the artist will know there is reflected light coming into the shadow, and can readily trace its source. But he must be careful not to make hasty inferences from this. The cloth is smooth, the shadow in question may be on a rough surface; if so, and if the reflected light shown on the cloth is weak, it may be completely absorbed in the shadow The cloth merely shows what light is coming to a surface; it does not show how much of that light is coming back from it.

All these little details should be kept in mind before an artist undertakes to paint reflected light, otherwise he may be going on a totally false scent with a corresponding loss to his picture. It is undoubtedly better to err by missing some of the reflected lights than by putting in some imagined ones that were never there. But if an artist is sure he has a reflected light before him, the problem of painting it is comparatively simple.

The reflected lights mix with the shadows exactly in accordance with the laws of light mixture mentioned in a former chapter. For what happens is nothing but a mixture of two rays of light. The ray of the reflected light mixes with the normal ray of the shadow, and the result is what the mixture of these two lights would be. It can be exactly reproduced on the color top, and it is

just by this means that it is obtained according to Cutler's technique.

The way it is done is this: Suppose we are dealing with the dark shadow omitting the half-tone for the moment. We have the disk that gave us that shadow — a certain proportion of the local color with the black to make the shadow. We find the source of the reflected light seen in the shadow. To use the same example we used in the last chapter, let us suppose the blue dress worn by the model was reflected in the dark shadow on one of her arms. We have the disk that gave us the dark shadow on the arm What we do is to take that disk (or preferably one just like it) and paint a stripe of blue on its edge where the black is. We put a stripe of blue in place of some of the black. Then we spin the disk and compare the color on the edge with the shadow in question. If the shadow and the disk do not match, we add or wipe out some of the blue until they do match; and when they do the color on the disk will be just the color of the shadow. Or if slit disks are used, a black disk is spun with a flesh colored disk in the proportion that gave the color of the deep shadow on the flesh. Then a slit disk of the blue dress is slipped partly over the black to such a proportion that when the three disks are spun together the shadow in question on the flesh is

matched. The color on the top will then be the color of the shadow as it is altered by reflected light.

Why not copy the color of the shadow directly? Because there are a hundred ways by which we could just miss it. But by getting our color on the top we could not go far wrong. We might get a trifle too much or a trifle too little blue. That would be all. The shadow would be right in any case. For we are simply doing on the disk what the light does on the arm — mixing a ray of shadow color with a ray of reflected color. We can hardly avoid getting it right.

To get the reflected light on the half-tones, the same thing is done. In this case, of course, the disk that gave us the half-tone is used. The rest of the process is the same. The reflected light in the half-tones, it will be found, is always less prominent than in the deep shadows. This is to be expected, for since half-tones give out a stronger light than the deep shadow, they can eat up more of the reflected light than the shadow can. Often there will be reflected light in the deep shadow but none in the half-tone simply because the light of the half-tone is strong enough to eat up all of the reflected light. But these matters will attend to themselves if the artist observes closely and does not stray too far from the color top.

There are two cases of reflected light, however, where the artist must go gingerly. One of them is where a color is reflected on itself as in the folds of dresses or in the hollow of clasped hands. Curiously enough, when a color is reflected on itself a change of hue generally takes place, and it seems to be impossible to find a law that will cover all cases. For instance, take some of the colors in Cutler's scale. No. 22 (a reddish violet) seems to turn redder when reflected on itself. On the other hand, No. 19 (a bluish violet) seems to turn bluer. No. 4 (almost pure yellow), No. 3, No. 2, and No. 1 (English vermilion) all seem to turn redder when reflected on themselves. But No. 24 (almost pure red) does not seem to change hue at all when reflected on itself. In short, when colors are reflected on themselves, they behave just as erratically as when they go up to highlights or down to shadows. No rules are of any avail. Obviously, these changes of hue cannot be reproduced on the color top. All that can be done is to caution the artist, so that when a color is reflected on itself he will observe carefully to see if there is any change of hue. And it is very important to make reflections of this sort correct, almost as important as to make the highlights and shadows correct. But all we can do is to give a warning.

The other ticklish case is where the reflected light is

white. In this case the color top can be used, but it must be used understandingly. When the reflected light is white, the result is the same as though the shadow were brought into higher illumination, and the color becomes not only higher in value but more saturated. It is evident that this result cannot be obtained by adding white to the disk that gave the shadow. For instance, suppose the local color of a dress is blue. Then a disk colored all blue would be the color of the dress in full illumination. And we found that a disk painted partly blue and partly black gave the color of that dress in shadow. Now suppose enough white light falls on that shadow to make the illumination as strong as the full illumination from which the local color was first obtained. Actually the color of the shadow will now be the same as that of the local color. But would a disk painted partly blue and partly white give us the blue of the local color? No, because the disk that gives us the local color is all blue. It is plain, therefore, that if white light is reflected into a shadow, we cannot obtain the correct color of the shadow by painting white in place of black on the disk. We could obtain the proper value of the shadow by that method, but the color would be much too low in saturation. The thing to do is to put the local color in place of the black on the disk. If it is a blue dress with

white reflected light falling upon its deep shadow, we take the disk that gave us the deep shadow on the blue and in place of the black on this disk add blue until the color of the spun disk and the shadow match. And they can be made to match if this is done. Reflected white light is simply an intensifier. To reflect white light upon an object in shadow amounts to the same thing as turning the shadow side of the object towards the light, which would mean that the shadow was coming back to its local color. And that is just what we do on the disk by putting local color in place of black.

These two cases — where the reflected light is white, and where the reflected light is the local color of the shadow — these two cases are the only ones that are puzzling. For the one all the artist has to remember is that when the source of the reflected light is white, he does not put white in place of black on his disk, but he puts the local color of the object in shadow. For the other no rule can be given; the artist must simply observe carefully. In all other cases the local color of the reflecting object is put on the disk displacing some of the black. Notice it is the *local color* of the reflecting object. If the reflecting object is a screen and is more or less in shadow, bring it out into full illumination and find out what its local color is. In most cases this can be done or

something equivalent to it. For instance, if the reflecting object is the wall in half-light, some part of the wall can always be found in full illumination. If there is no way to find the color of the object in full illumination, the artist must do the best he can by guessing at the local color.

Most reflected lights muddy the shadows. Yellow reflected on blue, for instance, may turn a shadow completely gray, and the same with all complementaries. But it is worse if the colors are just off the complementaries. Then some indefinable dirty color will appear to make a blot in the picture. But it is worst of all when a clearly defined color comes out of the shadows that is totally out of harmony with the premeditated color scheme. For all these reasons it is highly advisable to control the reflected lights. And they can be controlled about as easily as the colors of the background or of the model's dress.

There are two ways of controlling them — one by having the artist take a position so that he does not see the reflected lights, the other by arranging the composition so that the reflecting objects are of a kind to make harmonious shadows. The first method is so simple as to be almost ridiculous. Since there are no reflected lights on the illuminated parts of an object, an artist can

avoid seeing any of them by painting his model full into the light. Even if he paints his model at right angles to the light, he will not be troubled with many shadows. The troubles do not really begin until the artist takes his position somewhat back of the light. But if the artist paints his picture from the illuminated side of the model, he will have very little to do with reflected lights.

An artist, however, does not always wish to paint from the illuminated side of his model. As a rule, he will prefer not to, for by so doing he loses all the force of contrast that comes from juxtaposition of light and shadow. Accordingly, as a rule, he will prefer to use the second method of controlling his reflected lights, which consists merely in seeing to it that he gets the kind of reflections he wants. If the color of the wall beside the model makes a disagreeable reflection, let the artist hang something on the wall that will make the right kind of reflection. He can experiment till he finds the reflection he wants. With a little practice he ought to be able to tell approximately what the colors of his shadows will be without trying. The reflected lights should be just as much in the artist's mind as a part of his color scheme, as the color of his model's hair or the silk behind her head.

The problem of reflected lights is complicated because of the multitude of little details it involves. But the

principle at the bottom of the matter is simple enough, nothing more than the mixture of two rays of light. Because of all the little details, however, an artist is liable to be carried away with the subject, and to come to believe that the problem of reflected lights is the cardinal problem of painting. Against such an enthusiasm the artist must guard himself. Reflected lights are but secondary things which many good pictures can do completely without. The big things in painting light are the relations of shadows, highlights, and local color.

Chapter 6

OTHER SPECIAL PROBLEMS

A SPECIAL problem confronts the artist when in painting under studio light he has to represent objects like jewels and shiny metals which reflect more light than any pigments do, or objects like velvet and the deep shadows under furniture that reflect less light than any pigments do. In both of these cases the artist has to paint something that goes beyond the range of his pigments, and some sort of compromise or adjustment has to be made. The question is what sort of adjustment gives the most satisfactory effects of luminosity. In general, it is best to avoid these special problems when-

ever possible (and it usually is possible under studio lighting), because they compel the picture to be somewhat false in its most important relations. The best effects of luminosity are obtained where pigments are not forced beyond their capacity. The moment the range of lights in an object exceeds the range of pigments something of truth is sacrificed to mere dexterity. However, there are times when an artist wishes to paint beyond the range of his pigments, and what will he do under these circumstances?

First, what will he do with shiny objects? The great trouble with these comes in the highlights. Under studio lighting pigments can closely approximate the local color of even the shiniest objects, but they cannot come anywhere near the highlights. The highlight on silver, or nickel, or glass, or on white collars, or white silks are of a value far above white pigment. What, then, can be done? It depends largely on the importance of this highlight in the composition. If the highlight is small and would not be missed, the wisest way is to leave it out. There are some artists who never or rarely paint the highlights and the effect is still luminous. For aesthetic reasons it is often best not to cut up an area of color with a highlight. Or, again, what is perhaps better still in some instances, if the local color

is a little below pigment white in value so that there is a perceptible though slight value difference between the local color and the highest value obtainable with pigments, the artist can paint in the local color as it is, and then let pure pigment white stand for the highlight. The step from the painted local color to the painted highlight will not be nearly as great as the actual step, but enough to suggest the actual step. At the same time the local color will be exactly matched so that all the shadow relations will be true, and these are the most important relations. A color even a very little above the local color in value will be adequate for suggesting a highlight in this way. In cases like the above, when the highlight is left out or suggested with as light a color as is obtainable, the rest is clear sailing for the artist. For in both cases the local color of the shiny object can be matched in pigments, and therefore the relations between the local color and the shadows can be exactly obtained by the methods already described.

But sometimes the highlights are too important to be ignored or merely suggested. That is especially the case where the highlights cover a large area as they do in satins. The illuminated surface of a satin is often largely highlight. The artist must watch for such cases and not mistake large highlights of this kind for the local color.

When the area of a highlight is so large, it is obvious that it cannot be ignored. In such a case, supposing it is white satin that is being painted, the artist must use his whitest pigment for the highlight on the cloth. Then he will have to choose arbitrarily a light gray to stand for the local color, the selection being an estimate as to what gray will be best in this capacity. He should obtain this gray by mixing black and white on a disk (for a reason to be shown in a minute). Having obtained this gray for the local color, he can then proceed to obtain the shadows by the color top in the regular way, slight adjustment perhaps being made in the half-tones.

Now, having obtained these relations for local color, highlight, and shadows, the same relations must be observed throughout all the other lights of the picture. The local color on the face must be reduced with black on the color top to correspond with the reduction of the local color on the satin. That is to say, since the local color of the white satin was actually a match for the whitest pigment, and since for the sake of obtaining a highlight that local color was arbitrarily toned down on the color top with a certain proportion of black, then the same proportion of black must be mixed on the color top with the real local color of every object in the picture. This is the only way of obtaining the effect of a

consistent lighting under these circumstances. If a quarter of an inch of black was painted on the white disk to obtain the local color arbitrarily chosen for the white satin, then a quarter of an inch of black must be painted on the flesh colored disk to obtain what must be used as the local color of the flesh. And similarly a quarter of an inch of black must be painted beside every other local color in the picture. Whatever relations the artist makes to hold between highlight, local color, and shadow on the satin, those same relations must be made to hold for every other color in the picture. And unless a color top is used to keep these relations accurate, there is no telling where an artist will land. The principle at the bottom of it all is simply this, that whatever adjustments are made to paint a shiny object like satin, those same adjustments must be made on all the other objects right through the picture.

In the painting of objects that absorb an exceptional amount of light the artist is met by a problem very similar to the last one. Black velvet, for instance, is darker than any black pigment. The local color of black velvet cannot be matched by pigment, much less the shadow. Now, it is impossible to ignore the shadow the way a highlight can be ignored at times; hence, that alternative is removed at once. The shadow on the

black velvet will have to be painted, and all we have to paint it with is black pigment. Black pigment will, therefore, have to go to make the shadow,[1] and the local color will then be painted as a dark gray. This gray may be obtained by the artist either directly or by making additions of white on a black disk on the top. The artist must remember, however, that with velvets the interval between local color and shadow is much shorter than with other textures. By carefully observing what this interval is and remaining true to it, the artist can imitate very closely the effect of light on velvet. There is no need of reproducing the adjustment for the shadows of a black velvet throughout the other colors of a picture. With colored pigments the problem often disappears, because many of these pigments are highly absorbent. For example, ultramarine blue is of a value almost as low as pigment black, and consequently the local color and shadow of a blue velvet can often be exactly reproduced in pigments.

Another special point that was set aside further back was that of painting local discolorations due to one

[1] If by any means consistent with the general technique of the painting a black can be obtained blacker than the black of black pigment, of course that should be used for the shadow on the black velvet.

cause or another. The chief reason why these details were set aside was to get the artist to see his lights in a big way. It does not make much difference what is done about these little things in a picture so long as the big things are right. But once the big things are right then the little things can be attended to. If these details are sparse and isolated, the artist might as well paint them in directly. Many of them could perhaps profitably be omitted altogether. If there is any doubt about their color, however, the artist can check himself up on the color top. He would obtain the exact color then, but such exactness is perhaps unnecessary in such trifling details. But if the details are regular in their appearance, such as stripes or polka dots on a dress, then it is advisable to get these colors by the color top just as if they were important members of the color scheme. They are important enough to mar the light effect if they are wrong.

Those artists who are accustomed to paint by the pointilist or a similar method may wonder how Cutler's technique can be applied to their type of painting. The way is simply this. Suppose the artist has obtained the impression of his local color by putting on small brush strokes of three colors in juxtaposition. Then to find out the three colors to use in his shadow, he should paint

each one of these colors on a separate disk, and spin down each one on the top with black until it is the same value as the shadow. Then if he paints the shadow in small brush strokes with these three newly obtained colors in juxtaposition, he will find the shadow comes out right.

It must be admitted, however, that merely from the point of view of luminosity the pointilist or prismatic method is not so satisfactory as painting in large masses of color. There is a film of grayness that hangs before all pictures painted in this manner, caused by innumerable little irregularities of mixture occurring in the eye. This grayness reduces the saturation of the colors, and consequently the luminosity of the picture. On the other hand, there are aesthetic advantages in this method which an artist may on occasion find more valuable than the maximum effect of luminosity. While there are certain methods of painting especially adapted to the obtaining of luminous effects, there is no method to which Cutler's technique cannot be applied advantageously.

There is one point about the mixing of pigments that ought to be mentioned, for often the way an artist mixes his pigments to obtain a color makes just the difference between luminosity and dullness in a picture. It is

hardly necessary to say that an artist ought to mix as few pigments together as possible, for every new pigment added to a mixture takes so much away from the saturation on account of the impurities in pigments. If the right color can be obtained direct from the tube, that is best of all, but that can rarely be done. The artist should try to get his color by mixing not more than two or three pigments together. And he must remember that adding white to a mixture muddies it just as much as adding black. Good effects of luminosity can never be obtained except by keeping the pigments as pure as possible.

But the particular point we have in mind is that when the artist is toning down his colors from local color to shadow, he should use as far as possible a different dark pigment for each color he tones down. In the picture we imagined ourselves painting, the principal colors were blue, yellow, and orange. Well, if some black was used to bring the yellow down to its shadow, black should not be used with either of the other colors to bring them down to their shadows. We could get the shadow of the blue perhaps from ultramarine and green, and the shadow of the orange from some dark brown. In other words, as little black paint should be used as possible. A little care of this kind will produce a variety and con-

trast among the colors and save the picture from falling under a tone. Not but that tone has a certain aesthetic charm for which an artist would be willing to sacrifice some luminosity. But from the point of view of luminosity alone tone should be avoided as it invariably, and, when consciously used, purposely deadens the light. And there is danger that if an artist is not watchful he may throw his picture under a tone by a careless mixture of pigments, and then wonder why it looks so dead and lifeless. The danger is especially great in the mixing of shadows, and the artist should always be finding ways to bring these down by different pigments in each case.

Above all an artist should not think that because a color is darkened with black on the top to get a shadow, it must therefore be darkened with black in the pigment mixture to get the shadow. An artist who falls into this error has completely missed the point of this technique. The mixing of lights and the mixing of pigments are two totally different things, and conclusions drawn from the mixing of lights cannot be applied to the mixing of pigments. To obtain the shadow of a color on the top, the only right and proper thing to do is to mix black with the color by spinning. But to obtain the shadow of a color in pigments, black is the last thing to be mixed

with a color and is used only when nothing else will produce the desired result.

These are a few suggestions to an artist whose primary purpose is to paint light, and who has nothing else particularly in mind. For one reason or another he may prefer to disregard them. But at times they may prove useful to him.

Chapter 7

PAINTING IN WEAK AND STRONG LIGHT

UP to this point we have considered only what to do under studio lighting. But the conditions are somewhat changed when the lighting is either weaker or stronger than that. There are particular difficulties that arise when a picture is painted of objects in a dim light such as we get at dusk or in a strong light such as we get through a southern window. These difficulties will occupy us in this chapter.

Before asking ourselves how to paint objects in a weak or intense light, we must know what differences a change of illumination brings about. It is only by find-

ing a way of reproducing these differences that an artist can give the illusion of varying intensities of light. For all pictures are painted to be seen under a uniform illumination of about the intensity of north studio lighting. An artist cannot expect to have sunlight thrown on a picture that represents sunlight, nor can he expect to have the curtains drawn when a picture representing dim light is to be shown. Pictures of dim light and of sunlight alike must be painted to be seen in the moderate light of a room. The problem before the artist here in light is very much the same as that he has to meet in drawing when he has to represent three dimensions on a two dimensional surface. Here he has to represent strong or weak light in a light of an entirely different nature.

Consequently, just as an artist has to know the laws of perspective in order to draw correctly, he has to know the laws that accompany changes of illumination in order to paint light correctly. The first of these laws needs scarcely to be mentioned. The stronger the illumination the greater the saturation of the colors. Red is much redder in strong illumination, black much blacker, white much whiter. The second law is that the stronger the illumination the greater the difference of value between local color and shadow. Thirdly, the

stronger the illumination the smaller the number of half-tones. And fourthly, the stronger the illumination the greater the intensity of the reflected lights. In other words, under strong illumination all colors are brighter, there is a big jump between light and shadow with few or no half-tones, and the shadows are full of reflected light. If the artist keeps these laws in mind, he cannot go far wrong in representing different degrees of illumination.

Now let us take up the problem of painting weak light in detail. It is evident at once that all of these laws just mentioned can be complied with in painting weak light. If the range of pigments can cover almost everything under studio lighting, it can cover everything under weak illumination. But can it cover the blacks of a weak light? Yes, for notice the weaker the illumination the grayer the blacks become. The absolute darkness of a closet is neutral gray. An artist will have no trouble with his blacks until he gets them in fairly strong illumination. So, the range of pigments completely covers the range of colors in a weak light. As for making the jump between light and shadow small, and seeing that the passage from the one to the other is gradual and through many half-tones, he can easily do that. And there will be virtually no reflected light. The

only problem (and it is a big one) in the painting of weak light is to be sure that the objects are represented in their proper colors.

We are so in the habit of ascribing a certain color to an object because we know it is of that color, that we will often paint into a picture a color that we do not actually see. The same trick of mind that makes it impossible for an artist to see correctly what the colors of his shadows are, makes it impossible for him to judge the colors of objects in a dim light. If he knows an object is yellow, he is liable to paint it yellow in a dim light, while as a matter of fact it would be gray or greenish. For this reason it is advisable for an artist to obtain the illuminated color of all objects in a dim light by spinning them down on the color top just as if they were shadows.

For instance, if our model with red hair and blue dress sitting before a yellow curtain is to be painted in dim light, the thing for us to do is to bring her into full studio illumination and match the orange of her hair and the blue of her dress. (In matching colors like this it is important that the colors being matched be equally far away from the eye.) We should bring the yellow curtain into the light too and match that. Then we can reduce these colors with black on the color top until they are of the value of the dim light in which they are

to be painted. The shadows and half-tones would, of course, be obtained from these reduced colors by the regular method.

An excellent way for an artist to observe the effect of low illumination on colors is to make a spectrum with weak light. It will be discovered to have shrunk to three colors — the three physical primaries, red, green, and blue-violet. These are the only colors that survive in a very weak light. Hence if the artist wishes to get the true effect of a dim light, he must be careful of his yellow and orange hues. And the total effect should be of a cold blue-violet tone, all, of course, in dark, low-saturated hues. But these matters will mechanically take care of themselves, if the artist spins his local colors down with black, as just suggested, instead of trusting too implicitly his perceptions.

A problem allied to that of painting objects in dim light is the problem of painting objects at different distances from the source of illumination. For example, suppose the artist were painting two models one six feet from the window, the other twelve. Obviously the illumination of the second model will be weaker than that of the first, and the smaller the window that acts as the source of illumination the more rapid the weakening of the light as it diffuses into the room. Now, how will an

artist achieve an effect of consistent illumination in his picture when the situation is like this?

A simple method is as follows. Let him paint the model who is nearer the window first, and paint her as though she were the only figure to be painted, obtaining his local color, highlight, and shadows as we have shown before. Then let him bring the second model up to the position of the first model and there match the local colors of her flesh, hair, and dress. After that let him determine how much black it will be necessary to mix on the top with any one of these colors (say, the flesh tint) to bring it down to the proper dimness when the model is standing in her original position twelve feet from the window. For plainly the flesh tint will be darker twelve feet from the window than it is six feet from the window. When he has found what he feels to be the right amount of black with which to darken the flesh tint on the top (say, 1/4th black to 3/4ths flesh tint), he will darken all the other local colors he has obtained from the model with the same amount of black. That is to say, he will spin all these other local colors on the top in the proportion 1/4th black to 3/4ths local color. The colors so obtained will be the *lights* (notice, not the shadows) of the model in the original position twelve feet from the window. A consistent diminution

of illumination is obtained in this way as it never could be obtained by direct copying of the colors in the model's original position; for the dimmer colors are, the more difficult it is to copy them accurately.

The shadows on the second model will, of course, be obtained not by spinning down the original local color that was copied from this model while near the window, but by spinning down the *lights* determined for this model in her position twelve feet from the window, these *lights* being treated exactly as if they were the local color. These lights, moreover, or lighted planes on a model well back in a room are liable to have a good deal of reflected light in them. They are often too weak to absorb the reflected lights from walls and floor and also they receive the full glare of these reflected lights in a way illuminated planes near a window would not. The artist has to watch for these if he wishes to get a true effect.

In painting objects in high illumination we meet a new difficulty. The range of colors in bright light is many times greater than the range of pigment colors. The pigment range, as we saw, is approximately the same as that of colors in studio illumination, so all the colors we get in sunlight but not in studio illumination are beyond the range of pigments. This accounts for the fact that a studio picture luminously painted can stand

up beside and often browbeat a picture that represents blazing sunlight. The two pictures have to be painted within the same range of colors. As a general thing a luminous studio picture will be more brilliant and powerful than an out door picture, because the pigment range is adequate to it, and because it is not hampered with a multitude of adjustments and compromises. For the effect of intense light the artist has to rely chiefly on his treatment of shadows and reflected lights.

The sun is the principal source of the intense light painted by artists. There are other sources of intense light such as the city arc light, and stage lighting, and the nature of such sources has to be kept particularly in mind when their light is being painted. An arc light has blue in it, and stage lighting may be almost any color. By the laws of light mixture one can infer what effects the colors of these lights will have upon the objects they illuminate. Now, sunlight at noon is practically pure white, but in the morning and especially in the afternoon it is distinctly yellowish. Hence it is one thing to paint sunlight at noon, another to paint it in the morning or at the end of the day.

As noon sun is to all intents and purposes merely intense white light, let us see first how we should paint that, and let us suppose we are painting it indoors, the

light coming in through a southern window and falling on the model. Suppose also we are painting our same model with the red hair and blue dress sitting against a background of yellow. How shall we go about it? For one thing we shall paint without any half-tones and show a sharp line where the light ends and the shadow begins. Also we shall make as big a jump between the light and the shadow as we can in pigments without utterly losing our color in the shadow. Estimating the extent of this jump is the most important thing in painting intense light. The actual difference in value between the light and the shadow is, of course, far beyond the range of pigments to imitate. Some arbitrary difference must be chosen, and if the choice is not carefully made we run the risk of losing the saturation of our color either in the lights or in the shadows or in both places.

All in all the following plan is about the most satisfactory for dealing with this problem. We shall use the most saturated pigment we can find to represent the object in light. We shall use the most saturated orange we can obtain from our pigments for the lighted portions of the hair, the most saturated blue for the lighted portions of the blue dress, and the most saturated yellow for the lighted portions of the background. If any of these colors happen to be tints, we shall paint them as tints

but as saturated as we can get them in the tints. If the dress is a light blue, we shall paint it just as saturated a light blue as we can in pigments. If there is any doubt about what the color really is, we take it before a north window and get studio light upon it. The truth this choice of colors represents is that intense light does not so much raise the value of a color as increase its saturation. To obtain the best effect of strong light, it is better to approximate as nearly as possible the saturation than the value.

Letting the saturated colors stand for our lights, we now have the problem of choosing colors for our shadows. And it turns out that the best we can do for these is to take our saturated colors, paint disks with them, and spin them down with black to about the value of a deep shadow in studio lighting. If any darker value is used, the shadows will lose their color. If a higher value is used, there will not be a sufficient jump between light and shadow to give the effect of strong illumination. So, we use the same jump that we should between local color and deep shadow in the studio.

We have now obtained our colors for our lights and shadows. All that remains for us to do is to give the effect of strong reflected lights in our shadows. This we do exactly as if we were painting under studio light,

testing the results we obtain on our disks with the actual reflected lights we are painting. If the model is near the window, we must watch for the reflection of the blue sky in our shadows, and by spinning mix our shadow colors with a little blue.

When painting forenoon or afternoon sunlight, we have the yellowness of the light to consider. This yellow in the light makes yellows yellower, blues grayer, and turns all colors a little towards yellow reducing the saturation of any that have blue in them. By turning the colors towards yellow we do not mean that any yellow actually appears in all the colors due to the yellow illumination — purple, for example, becomes redder — — only that they turn in the direction of yellow and away from blue (cf. color cone, p. 19). We ignore the loss of saturation in the blues, since pigments are not saturated enough to give the full amount of saturation anyway. But the turning of all the colors towards yellow makes a problem in obtaining our shadows. The only accurate way of solving this problem is to take the object under a north studio light and see what color it is in white illumination. We take our model with her red hair and blue dress before a north window, match the red of her hair and the blue of her dress in that light, and lower these colors on the color top to the value of a

dark studio shadow. That will be the shadow color we shall use.

But the color we reduced with black to obtain this shadow color is not the color of the object in yellow afternoon sunlight. The illuminated portions of the model's hair in yellow sunlight will be yellower than in the light of the north studio window. The first thought that occurs to one for obtaining the proper color is to mix yellow on the top with the orange of the hair. But if this is done we shall lose some of our saturation in the mixture. It is better to copy the color of the hair directly, or to choose arbitrarily an orange a little yellower than the local color of the hair and use that in the picture for the illuminated portion of the hair in sunlight.

If light from the blue sky is being reflected in the shadows, blue must be added to the shadow color on the color top. Indeed, it will be found that adding blue to the shadows will make the lights warmer and add to the yellowish effect of the sunlight. This is a fact worth remembering. And the opposite also holds true that by making the shadows warm the lights will appear cold. An artist can in this way control his lights by his shadows. But in painting yellow sunlight it is better not to rely entirely on the shadows but to shift the lights as explained above.

Chapter 8

OUT OF DOOR PAINTING

IN painting out of doors an artist has to rely almost entirely on his knowledge of how light behaves and his experience in painting it. An artist cannot very well carry a color top into the country with him, and even if he does it could not greatly help him there. There is a method by which he can study on a top indoors the way light behaves out of doors, as we shall see later, and it is a method of great value to an artist for increasing his knowledge about out of door light. But the method does not show him on the spot what each particular color in the picture should be as he is painting it. In the

main the artist has to depend on his knowledge and experience. It is consequently more necessary out of doors than indoors to know just how light behaves. And as a matter of fact it behaves out of doors in many respects quite differently from the way it does indoors. We shall be treating in this chapter chiefly the problem of sunlight out of doors, since that is the most difficult of the out of door problems. If the artist knows how to paint a sunny day, he can work out fairly easily how to paint a dull day.

The various facts mentioned about sunlight in connection with indoor painting in the last chapter must not be forgotten. Sunlight or any intense light, it must be remembered, not only raises the value of a color but also increases its saturation. Consequently, the artist must paint the illuminated portion of an object at the greatest possible saturation, and the shadow should be less saturated than the illuminated portion. That is to say, sunlight eats the dark and the gray out of colors, and consequently where sunlight falls on a color the color is not only higher in value but more saturated. Also, it must be remembered, that sunlight at noon is nearly white but in the forenoon and afternoon it is distinctly yellow (turning to orange and even to red when the sun is very low). Consequently, if an artist is paint-

ing in the forenoon or afternoon when the sun is yellow, he must remember that the yellow will turn all the warm colors a little towards yellow and will eat some of the blue out of all the cold colors where sunlight falls upon them.

Now, in painting sunlight out of doors the cardinal fact the artist must keep contantly before his mind is that there are essentially only two values. There is one big mass of sunlight and one big mass of shadow. And the first impression a person should have when he looks at a picture of sunlight should be of these two masses. If anything is done to break up these masses so that there will seem to be more than two values, half of the effect of strong sunlight will have gone out of the picture. Therefore, an artist should if anything exaggerate this fact. Anything in the illumination of the sunlight that suggests a different value should be sacrificed or modified for the sake of the luminosity.

But the question arises how great an interval there should be between the value of the sunlight and that of the shadow. This is a very important question and has to rest in the last analysis on the judgment of the artist. The jump from light to shadow is, of course, in nature far beyond the range of pigments to imitate. Some sort of adjustment is necessary. But one point is obvious

and that is that the jump should be as big as possible; for the more intense the illumination the greater the jump from light to shadow, and the illumination of sunlight is the strongest we get in nature. Consequently, if we are to give the effect of strong sunlight illumination, we must make as wide a jump between light and shadow as we can in pigments. On the other hand, we must keep our colors well saturated both in light and shadow. And this is what makes the trouble. Pigments lose saturation very rapidly as they leave middle value. They lose it as they go towards white; they lose it as they go towards black. Yet in nature the colors both in light and shadow are of high saturation.

What to do depends somewhat on the colors painted. If the colors in illumination happen to be themselves above middle value (that is, tints) there is no difficulty. That is, suppose the object we are painting is pink or light blue, then we should paint it in sunlight the most saturated pink or the most saturated light blue that we could to match. We could then make a big jump to a little below middle value, and paint the shadow a well saturated red or blue. We could do this because our illuminated color was above middle value to begin with, and therefore gave us an opportunity to make a big jump to the shadow and still have the shadow saturated.

The trouble comes when the illuminated object is of a color of about middle value or lower. For example, suppose the object is a brilliant saturated red in illumination. Now, in nature there will be a big jump to the shadow and that will be a dark saturated red. But if a jump in pigments were made anywhere near comparable to that made in nature, we should land practically at a black. And a shadow painted in such a color would have no luminosity because it would have no saturation. But we must have saturation in our shadows and consequently must use a fairly saturated red, which means a red of moderately high value for pigments. But we must also have a respectable jump between our light and shade otherwise we shall lose our effect of sunlight. The best thing to do in such a case is to paint the red in illumination a little lighter than it is. That gives a chance for a wider jump without losing too much in saturation.

At the same time if we turn the color in illumination a trifle towards yellow and the color in shadow a trifle towards blue, we can give the appearance of a still wider jump between light and shadow. Separating the light and shadow in this way, moving the light towards yellow and the shadow towards blue, we give the effect of a much wider difference of value than actually exists in

the picture, and at the same time retain good saturation in our colors. The reason we can do this without the appearance of artificiality is that the sun naturally makes the lights out of doors yellow and the blue reflection of the sky naturally makes the shadows blue. We simply exaggerate and take advantage of a fact for our own purposes which nature produces of her own accord.

Now, if we have our two big values of light and shade, and without losing too much saturation have established a wide jump between them, the next thing to consider is the reflection of the blue sky in our shadows. It is hardly necessary to say that the reflection of the sky has no effect upon ordinary illuminated surfaces out of doors. Though the reflection of the sky is strong, it is so weak compared with the direct sunlight that we are unable to see any difference that it makes. The only exception is where we get highly reflective surfaces like sheets of water. These return to us like a mirror whatever rays of light come into them. And since a sheet of water is so placed that it generally returns to us the blue of the sky, we generally see the water blue. But there is one point the artist must remember when painting water and that is that it is always darker or lower in value than the sky, because even in so perfect a reflector

as water some light is absorbed with the result that the value is lowered.

Exceptions of this sort aside, the blue reflection from the sky has usually no appreciable effect upon the illuminated surface of an object but only on the shadow. This blue reflection must be kept constantly in mind, otherwise in a negligent moment it will be forgotten and something will seem wrong with the picture. This blue reflection of the sky is, of course, a light and behaves with the colors in shadow as one light behaves with another. That is, it follows the laws of light mixture. It turns all the cold colors towards blue and eats some of the yellow out of all the warm colors.

Hence in morning or afternoon sunlight when the yellow of the sun turns all the colors under illumination towards yellow, and the blue of the sky turns all the colors in shadow towards blue, there is a strong tonal separation of light and shade. The lights are under a yellow tone, the shadows under a blue tone. One of the secrets of powerful effects of sunlight is to give the sense of this separation. The parts of the picture in light should be distinctly warm, and the parts in shadow distinctly cold. The light and shade should draw apart from each other not only in value but in tone. To obtain this effect the artist must have continually in mind the laws of light

mixture; and when he paints a color under yellow sun light, he should remember what yellow does in a ligh mixture with that color; and when he paints the sam color under the blue reflection of the sky, he should re member what blue does in a light mixture with tha color. If he consistently does this, his lights will turn out warm and his shadows cold as he wants them.

But what happens if no blue from the sky is reflected into the shadows? Such would be the case with shadows under trees or under the arches of a church. Shadows of this kind are different in three ways from other shadows. First, they are warmer because they have not the blue reflection of the sky upon them; secondly, they are generally much more richly filled with reflected light from neighboring sunlit objects; thirdly, they are darker because the reflection of the sky is so much added light to the other shadows. It is easy enough to paint them warmer. We simply paint them as they normally would be ignoring the blue that has to be considered for most shadows out of doors. And the problem of reflected lights is no more difficult here than in other cases. But we have to be very careful how we paint these shadows darker. For if we make them too dark, we will seem to have added another value in the picture. But nothing should be allowed to break up the sense of

two, and just two, big value masses. For if these are broken up, the feeling of strong sunlight illumination will be lost. Consequently, these darker shadows must appear merely as accents in the big mass of shadow. They may be a little darker, but only a very little.

A similar problem arises when light is seen shining through an object, as, for instance, through leaves or through a thin parasol, a condition often producing magnificently saturated colors. The intensity of light is reduced from the glare of sunlight, but it is not reduced to the value of a normal shadow. There comes again the danger that the artist will introduce a distinct third value that will ruin the strong luminosity of the picture. It is best in a case like this to change the value of the light coming through the leaves, or whatever the material may be, a little but not enough to give the appearance of a third value, only enough to appear as a variation or accent upon the mass of light. It is obvious, too, that in the case of sifted light such as we are now speaking of, the shadows that occur under the illumination of this light will be much deeper and stronger than normal shadows. This difference must not be neglected, yet at the same time, as said of similar shadows a moment ago, these shadows must not be painted so dark as to create the impression of a distinct third value. In all cases we

must never permit anything to interfere with the total effect of two big masses of light and shade.

There will, of course, be strong reflected lights in the shadows, for the stronger the illumination the stronger the reflected lights. A green lawn in sunlight will throw up a strong green reflection on the shadows under the eaves of a house. But these reflections raise no new problems. They simply have to be watched for. Occasionally, a little complication arises where a shadow receives reflected light from the ground and also from the sky. In such a case the result will be whatever a mixture of the blue light with the color of the light reflected up from the ground would make. As a general thing, however, when there are reflections from the ground, there are no reflections from the sky.

As objects retreat in space certain changes take place that are exceedingly important for an artist to notice in order that he may obtain a good effect of distance. They are changes due to so-called aërial perspective. If we stand at a window and look indoors, the further away objects are the darker they become. But if we turn and look out of doors, we shall find it just the reverse: the further away objects are the whiter they become, for white light is added to them. Moreover, on account of the color of the atmosphere the further away objects

are from us out of doors the bluer they become. And lastly, the further away objects are from us out of doors the less difference there is between their light and shadow. At a considerable distance away all objects appear of a uniform value, appear without any perceptible difference of light and shade whatever. That uniform value is slightly lower than the light value of the foreground. Essentially what happens is that the darks melt away in the distance, but the lights hold their own. A white house far away on a hillside will gleam almost as white in the distance as if it were twenty feet away, but a gray barn on the same hillside will be lost from sight. The reason is obvious. The gray barn reflects so little light that the light in the atmosphere completely overcomes it and the barn melts into the hillside and disappears. But the white house reflects such a quantity of light that it completely overcomes the light in the atmosphere and does not appear the least bit blue even at so great a distance. For the same reason shadows disappear in the distance but the lights tend to hold their own. Altogether, the further away an object is the whiter its color, the bluer its color, and the less difference it shows between light and shadow. If an artist wishes to paint distance accurately, he ought to keep these facts in mind.

Another thing an artist should remember as he paints out of doors is that his picture is to be seen indoors. A pigment that he puts on his canvas out of doors with the bright sunlight shining down upon it will look quite different when brought into the moderate indoor light. All colors will be somewhat duller indoors so that a picture painted out of doors is bound to drop when brought indoors. Every landscape painter has experienced disappointment at one time or another from this fact. But worse still, the relations of colors to one another change when seen indoors. The reds and yellows are relatively duller, the blues relatively brighter. The artist has contantly to make allowances for these changes.

These are the main points that an artist should keep n mind when painting out of doors. And now it is time o show how even when an artist is indoors he may inrease his knowledge of the way light behaves out of oors. It should never be forgotten that color out of oors just as much as indoors is light. Consequently, ust as we could reproduce the indoor light effects on the olor top and receive valuable information thereby, so re can reproduce in a degree out of door light effects on ne color top. We cannot reproduce the out of door alues and saturations; they expand far beyond the ange of pigments. But we can reproduce the light mix-

tures that occur out of doors, and find out the hue thes mixtures make. There are few better ways of learnin the analysis of out of door sunlight than by workin in spare moments with a color top indoors. The mor a man knows about anatomy the better he can dra a figure. In the same way the more a man know about the nature and behavior of light, the better hi chance of obtaining an effect of luminosity in hi pictures.

Let us take a single example of out of door color, an analyze it on the color top, just to show how the anal ysis is done. We will take a fairly difficult instance, toc so that it will be representative. Suppose we are con sidering the color of an old shingled roof in out of doo sunlight. We shall suppose it to be the middle of th afternoon when the sun is fairly yellow. First we shal look for the local color. If there is any portion of th roof in shadow where no reflections fall, that will give u the local color, or if we can bring a shingle from the roo into the studio. But if we cannot do either of thes things, the local color will have to be obtained by esti mate. For obviously we cannot get the local color fron the sunny parts of the roof since they are tinged by th yellow sun, nor from most of the shadowed parts sinc the blue reflection of the sky tinges them. Suppose

however, we find or estimate the local color to be a certain gray-violet.

Now we get that gray-violet on the color top by mixing saturated violet with black and white. We take the most saturated violet we can find of the same hue as the gray-violet and paint a disk with it. Then we spin that disk on the top with a black disk in suitable proportions. This will probably make too dark a violet. We put a white disk in with the black and violet ones. With a little adjusting of the proportions of the white, black, and violet we get a color on the spun top which is the local color of the roof — a certain gray-violet.

Now we want to find the color of the roof in sunlight. We know that sunlight eats the dark out of a color. Therefore, we take away all the black there is on the top and put violet in its place. That amounts to the same thing as taking the dark out of the color. Next, we know that sunlight puts yellow into a color. Therefore, in place of some of the violet and some of the white we put part of a disk of saturated yellow. That amounts to putting yellow into the color. Now we spin the disks. The result will be a sort of pink, and that as a matter of fact will be very nearly the color of the roof in strong sunlight. It will be the correct hue, but the value will have to be adjusted.

Now we want to know the color of the roof in shadow where the reflection of the sky falls upon it. We take our proportions of black, white, and violet which when spun gave us the local color of the roof. As far as value goes we know that this color is about right, since the local color of an object is about its color in normal shadow. But we also know that the blue reflection of the sky will make this shadow bluer. Therefore, in place of some of the black on the top we put some of a disk of blue. That amounts to adding blue to the shadow. When the top is spun we get a bluish gray-violet.

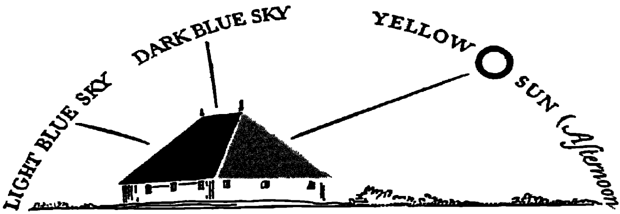
Now if we paint the sunny parts of the roof in a picture with that pink we obtained above (taking pains first to adjust its value), and the shady parts with this bluish gray-violet, we shall find that the roof painted in the picture will have a quite luminous effect. Practising this way on the color top indoors the artist will soon get in the way of analyzing colors so that when he paints out of doors he will be able to analyze the various color effects in his head, and will know what the right color is by something more than guesswork. But some sort of practice like this is exceedingly helpful to an artist seeking luminosity in landscape painting. For a man is just as likely to err in his observations of color out of

doors as indoors, and assistance of any sort tending to keep him on the right track is valuable.

So far we have been speaking only of sunlight painting out of doors. That is the most difficult problem of luminosity. Painting light on dull days is simple in comparison. It will suffice to mention a few characteristics of light effects on a gray day. There are no blue reflections from the sky in the shadows on a gray day. Moreover, the illuminated surface of every nearby object on a gray day gives the object's local color. This in itself greatly simplifies the problem of painting the light. Out of door lighting on a gray day approaches studio lighting. Again, the light on a gray day being weak, the shadows according to the law we know are much more numerous than on a sunny day, less defined, and with smaller jumps between. The light is diffused and softens all sharp edges. Also, because the light is weak, the atmosphere is felt more strongly. Distant hills are bluer, and the distinction between light and shade even sooner disappears on a gray day than on a sunny one. Nearly all of these are facts that could be readily inferred from our knowledge of the effects of weak light.

But the fundamental fact that an artist should remember indoors and out is that color is light, and that it

is light that he is painting. When a reflection falls on a shadow, it is one ray of light mixing with another ray of light. If the artist forgets that it is lights that are mixing, he is lost. Luminosity in a picture is nothing more nor less than actual reproduction as correct as pigments can make it of the light effects of nature.



Chapter 9

WIDER APPLICATIONS OF CUTLER'S SCALE

We asked ourselves the question in the chapter describing Cutler's scale whether the use of the scale as there described would not make an artist's work mechanical, and formulated, and narrow; and we admitted that if used as a recipe and without the play of common sense, it probably would. It would restrict a painting to a certain number of established colors, would confine it to a certain rather artificial lighting, would hold it to a given set of conditions that is comparatively rare in actual experience. Our subsequent discussion of reflected light, strong light, dim light, sunlight, and the countless

lesser problems of light that confront an artist in normal experience, show how limited an application Cutler's scale would have if it were held down to our description of it in the earlier chapter. What we must now do is to show its wider applications, how without restricting the field of painting, without even making its appearance with one of its original colors in a picture, it may still act as a ballast in the heart of the work that keeps it steady and true to its lighting.

We could not have explained these wider applications earlier, because they involve all the facts that have been explained since. Indeed here everything that we have said meets. Scale and technique cease to be distinguishable, and all our principles converge and commingle. They come together as they do in the actual execution by any master. The student must follow the rules in their order, one, two, and three; must now paint by the scale, now by the technique, now get the shadow, now the reflected lights; each case must have its turn, so that the student may study it well and learn to understand its nature. But when the facts and methods have been learned and the knowledge become half instinctive, when, in short, the student has become the master, then all the facts and methods come to bear upon each detail of a picture together, and modify one another

half unconsciously so that perhaps not one of them finds its complete fulfilment yet all of them are better represented than in any student's work. In the last analysis, the wider application of Cutler's scale means the application of that scale to painting under the modifications of everything else that we know about the painting of light.

In order to make this wider application clear, let us consider the scale from a new point of view. Let us consider it not as an absolute unchangeable thing fixed in one place, but as something that can move. Let us think of it, for instance, as a many colored coat like Joseph's coat, a coat painted with 168 squares, a square for each color in Cutler's scale. And let us suppose Joseph is wearing this coat and standing before us in moderate studio light. That is approximately the light in which pictures are meant to be seen, and consequently the light for which pictures ought to be painted to be seen. It is also the light under which we assume the artist makes Cutler's scale as described in Chapter 3. It is the normal light for the art of painting. Consequently, as Joseph stands in this moderate studio light, we see his parti-colored coat in exactly the hues and values of the scale as we derived the scale. In short, the scale seen in that light is the normal scale; and when we

speak of the normal scale hereafter, what we shall mean is the scale seen in moderate studio light.

But now suppose Joseph moves off into the dim light in the rear end of the studio, or suppose he goes up into the bright light next the window, or suppose he goes out into the street in the sunlight, or off across the road where atmospheric changes begin to be felt. He is wearing the parti-colored coat all the time. In a sense it is our same Cutler's scale all the time. But none the less we know from what we have studied of the effects of different kinds of lighting upon color that with each move Joseph makes every color on his coat changes. There is a different Cutler's scale for every different lighting, yet so far we have described only one of these scales, viz., the normal scale, the scale as it appears in normal studio lighting.

The situation is especially clear if we consider a landscape in sunlight. There is the foreground, middle distance, and background. There is a different Cutler's scale for each of these. Furthermore, in the foreground there is the blue mass of shadow and the yellow mass of light, a different Cutler's scale for each of these. There may be masses of shadow reflecting the green of the grass, a different Cutler's scale for that. In short, let Joseph walk into the foreground, into the middle dis-

tance, into the background; let him stand in the sunlight, in the shadows blue from the reflection of the sky, or green from the reflection of the grass: he is wearing the same coat in each position, yet in each position the coat is a little different. Spread the coat out in the sunlight, and its blues are diminished; spread it out in the blue shadows, and its yellows are diminished; spread it out in the green shadows, and its purples are diminished; take it into the distance and spread it over a hill, and all its patches are melted into a modulated surface of soft violets and blues. For Joseph's coat is but the cloak of nature. Yet all of these different scales have to be represented in a picture of this sunlit landscape. In one picture five or six different Cutler's scales may have to find representation.

How is this to be done? One thing is clear, and that is that the scale as seen in normal studio light, the normal scale, is the standard scale. Colors seen in that light are the only colors that will ever be seen in a picture, simply because people are not in the habit of looking at pictures in closets or out on the lawn. That normal light is the average light of all rooms and galleries. It is, therefore, the standard light for the artist; and, accordingly, the scale seen in that light is the standard scale.

If that point is clear, what follows is obvious. All the

changes produced in the appearance of the scale as a result of different lightings — the changes we see as Joseph walks about from place to place — have to be thought of by the artist in reference to the normal scale. They have to be thought of in reference to the normal scale because the normal scale is the scale seen in normal light, and that is the light in which all colors must ultimately be seen. If an artist, therefore, is going to paint Joseph's coat in, let us say, dim light, the way he should think of the colors of the coat is this: as the colors of the normal scale reduced on the top by, say, one-half of a circle of black. In other words, if the artist sets up his easel in the normal light of the studio, and takes the normal scale and reduces every color in it on the top with half of a circle of black, and if he then paints Joseph's coat with this reduced scale, he will get a representation of the coat that when seen in normal light will look as if it were in dim light. The artist obtains this true effect by regarding the colors in the dim light in reference to the normal scale, to the standard. If you will, the artist measures the amount of divergence of the colors in abnormal lighting from their appearance in normal lighting, and by consistently reproducing that divergence in color in normal lighting, he can make colors in normal lighting look as if they were under ab-

normal lighting. In this case the amount of divergence is half of a circle of black. By consistently reducing on the top with a half of a circle of black every color in Joseph's coat as it appears in normal light, the artist is able to make these colors look as if they were in dim light. The effect is produced and the appearance of truth given because the artist has kept his colors in touch with the standard normal scale.

It will be found the same all the way through. If while our artist is painting the sunlit landscape we were describing a moment ago, he thinks of his colors not as single isolated hues and tints in nature, but as colors of scales diverging thus and thus from the normal scale — the colors in the sunlight being such and such colors out of a scale which consists of the normal scale yellowed to a certain degree, the colors in the blue shadows being such and such colors out of a scale which consists of the normal scale blued to a certain degree, the colors in the distance being such and such colors out of a scale which consists of the normal scale softened into tints of violet and blue — if he thinks in this way of his colors as members of sequences having a determined relation with the normal scale (as colors out of Joseph's coat seen in positions more or less removed from the normal conditions of studio lighting), then when he brings his picture into

the studio it will look as he expected it to look, true to nature. It will look so because he has been steadying himself all the time by the normal scale. Each new lighting will not cast him adrift without shore or star or compass to guide him, for he has the normal scale to direct his course all the way and to bring him safely into port in the end. Used in this manner the scale will perhaps not make its objective appearance in the whole painting of the picture, or only one or two of its colors will be brought out and if possible by way of verification spun up on the top with the known modifications due to the abnormal lighting; but all the while the scale will be guiding the picture towards the correct appearance it must make in normal lighting.

In fact, so efficacious is the scale as a landmark that an artist with sufficient immediate experience with nature can stand in his studio and paint deductively from the scale a picture of any abnormal kind of lighting, and be sure that it will come out true. Even the student can see how this is possible. We know what the effect of sunlight, for instance, is upon colors in light and shade; we know what sunlight would do to the scale, what Joseph's coat would look like in the sun. Given any color in the scale, given its position in the sunlight whether in light or shade, whether with re-

flected lights or without, and we can deduce what that color would look like, and can spin up on the top the nearest approximation to it for normal lighting. And if we wished to make use of a color that is not in the scale, we could take its offset, so to speak, from the nearest color in the scale, and the scale would still guide us without binding us.

Under these conditions the scale is no longer in any sense a restriction. The artist is not compelled to walk in the gridiron of trodden, even paths; the no-trespass signs are taken down; he may stroll across lots, may wander outside the confines of the park, may climb up into the hills. But wherever he is, even on the top of the farthest peak, the little garden of formal, well trimmed paths will show him how far he has gone, and how he may get back. For in the end he always has to get back, or else he perishes. We must, however, not omit this opportunity to give a bit of advice to the young ones, and that is: Let them take care not to walk on the grass between the paths until the grass has had time to grow and take root.

Chapter 10

COLOR SCHEMES

THE first thing and the last thing to consider in every picture is its aesthetic quality. For the purpose of a picture is to please, and if heaven grant it, to be beautiful. Tubes, brushes, color tops, and color scales, and all the technique and knowledge that goes with these are but means to the end of beauty and enjoyment. An artist is liable to forget this. Preoccupied with the hundred and one technical difficulties that arise between the conception of a picture and its completion on canvas, an artist is liable to lose sight of the conception and to fall into the way of thinking that a picture is nothing but the

overcoming of technical difficulties. A picture that has nothing to its credit but a perfect technique will be a remarkable exercise, and may have a sort of classic beauty, but it will lack many things it might have had besides.

We have had our attention so closely focused on technical matters throughout this book, that it seems well for a short time at the end to lift our heads above the spinning of tops and the mixing of pigments and see what there is in color and light beyond these things. What we have particularly in mind is color schemes. From time to time during the preceding pages color schemes have been mentioned, but always with reference to luminosity. If the maximum effect of luminosity were desired to the neglect of everything else, such and such color schemes were best. But now we wish to consider color schemes on their own merits entirely apart from all technical considerations.

There has been a great deal of theorizing about color combinations. Some men have said that complementaries make the best color combinations. Others that colors just off the complementaries are best. There is a famous theory religiously followed by some artists which states that when a picture is painted with several colors, they should be so chosen that if they were mixed to-

gether they would give gray. Unfortunately the man who was first responsible for this theory did not know what is now well known that colors mixed in light give entirely different results from what they do when mixed in pigments; and he based his theory on the mixture of pigments.

The thing for an artist to do is to throw over all these theories once and for all, discard them and forget them, and listen to no new theories. And then let him keep in mind just this one fact, that every color combination no matter how simple, no matter how complex, is an emotion. Some combinations are sad and mournful, some are jubilant and exhilarating, some are funereal, some are boisterous, some are courageous, some are timid, some are plaintive, some are impudent. There are as many emotions in colors as in sounds, and a man is as much at the mercy of a painter's palette as of a violin, if the two are only used with the same skill.

But are not some of these color combinations unpleasant, and should they not be avoided? No, because for a man who is thoroughly educated to color there is probably no color combination that is inherently and always unpleasant. That is just why all theories on this subject are an evil. A theory says these combinations are good and these combinations are bad. But in point

of fact there are no combinations that are bad, in the sense of being always and in all conditions bad. Some combinations are sweet and some combinations are sour and bitter. But at times we like combinations that are sour and bitter. If we wish to feel a bitter emotion, we want a bitter color combination to give it to us. But if we are fanatic believers in a theory and that theory says that a bitter combination is bad — as most theories do say — then our hands are tied, and we simply cannot produce the emotion we desire. There is no color combination that under proper conditions of time and place and circumstance could not be the best combination. When people first saw the oriental combinations, they did not care for them, but now they admire them. They have become educated to them, and so with all combinations. There are no such things as inherently bad combinations. But every combination is an emotion, and every combination even to minute changes in the proportions of the colors used is a different emotion, and art could not dispense with one of them.

But how is an artist to know what emotion a combination will evoke? By trying it on himself, or if you will by intuition. An artist is presumably a person sensitive to color and to all the nuances of color. He of all people ought to know best what the power of a color

mbination is. Certain rules could be given. Sat-'ated colors tend to be exciting, grays to be quieting, ıd the like. But they could not determine the finer 'adations of emotion which make just the difference be-veen the good and the great. The artist himself is the ɜst judge of these things, and with experience his taste ·ows more and more sensitive. There is no danger but ıat his taste will develop naturally if he can only keep ɪt of the clutches of false theories. And the test of a ılse theory of color combinations is this: Does the ıeory assert that such and such colors in combination ɾe absolutely and always good, and such and such other ɔmbinations absolutely and always bad? If it does, ıe theory is false.

This must not be taken to mean that combinations of olor can never be called bad. If the composition and ubject of a picture are dominated with an atmosphere f quiet and reserve, why then a violent and shrieking ombination would be most decidedly bad. It would be ad because it would be out of harmony with the dom-ıant emotion of the picture. In much the same way urther back in this book we said that combinations of omplementaries and of saturated colors were best for btaining effects of luminosity. If an artist with his ıttention concentrated on luminosity should paint a

picture with a combination of grays, we should say the combination of colors chosen was bad. We should say so because if his intention was to get a strong effect of luminosity he had chosen a color scheme that greatly reduced his chances of success. But we do not in the least mean that combinations in low saturation are absolutely and always bad. On the contrary, they are very beautiful, and in many cases they are the only proper combinations to use. Combinations of colors, therefore, may be distinctly bad in their relation to the dominant emotion or purpose of a picture, but no color combination can be absolutely and always bad.

The one consideration an artist should have in selecting his color scheme is its suitability for the picture he has in mind to paint. Will it give the emotion he desires, will it be in sympathy with the rest of the picture, will it further the sense of luminosity, if that happens to be a prominent feature in the picture? These are the things for an artist to think of when selecting his color scheme, not some abstract rules from a fantastic theory that lies like so much rubbish and lumber in his path. And behind all this lies the one fact, which the experience of artists themselves will substantiate, that all color combinations are pleasing under the right circumstances.

)ne last word about luminosity. This book has been
upied with a description of a technique for obtaining
effect of luminosity in a picture. The technique it-
f is only a means. But the end for which that tech-
ue is a means is very beautiful. People enjoy light.
ey love to feel that there is light in a picture sur-
ınding and enveloping the objects there. It is some-
ng of great value desired for itself. And the value of
s technique may be measured by the end it serves.
r the whole purpose of this technique is to show the
ist a method of getting into his picture a feeling of
ht.

Appendices

Appendix 1

In case the artist should wish to make still further subdivisions of value in the scale, it seems advisable to give the mathematical principle from which the proportions of light and dark can be derived. It is the principle of squares, and at least within the range of lights the artist will employ it verifies experimentally. The principle is very simple. Let us explain it graphically first. And for simplicity let us talk only in terms of black and white; but any low value could be substituted for black and any high value for white.

Draw a square. Label the upper right hand corner white and the lower left hand corner black. Draw a diagonal from white to black. Now we wish to know what proportion of white to mix with black on the color top to obtain a value half way between white and black. We pick out the point on the diagonal that is half way between white and black, and we draw two lines from that point, one perpendicular to the top of the square, and one perpendicular to the right hand side. Now that part of the square that is to the right of these boundaries represents the proportion of white to use on the color

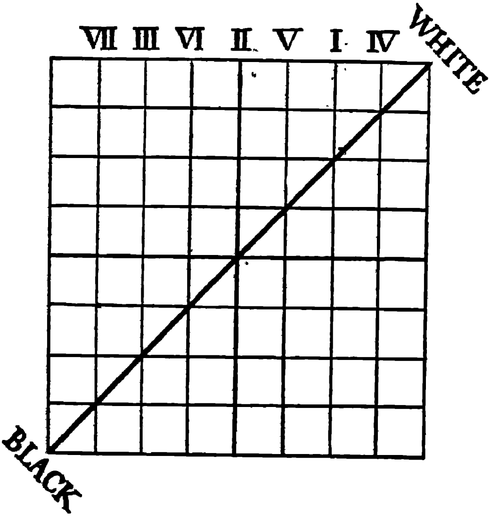


FIG. 5

W

Degree of value x	Scale No.	Prop. of white y	Prop. of black z
7/8	VII	49/64	15/64
3/4	III	9/16	7/16
5/8	VI	25/64	39/64
1/2	II	1/4	3/4
3/8	V	9/64	55/64
1/4	I	1/16	15/16
1/8	IV	1/64	63/64

Bk

top, and that part of the square that is to the left of these boundaries represents the proportion of black to use. In this case the boundaries we draw divide the square in the proportion of 1/4th to 3/4ths, as a glance at the diagram shows. Hence, to get a value half way between black and white we use on the color top 1/4th white to 3/4ths black.

Or suppose we wish to find what proportions of black and white to use on the color top in order to obtain a value a quarter higher than black in the range black to white. We find the point a quarter of the way down the diagonal from white to black, and from that point draw lines perpendicular to the top and right hand side of the square. A glance at the figure shows that these lines cut off 1/16th of the square on the white side and 15/16ths on the black. Hence, to obtain a value a quarter higher than black in the range black to white, we use on the top 1/16th white to 15/16ths black.

Whatever degree of value (1/2, 1/4, etc.) we wish to obtain above black in the range black to white, we take that degree on the diagonal measuring from white to black, draw lines perpendicular to the top and right hand side of the square, and whatever part of the square is cut off to the right of these boundaries represents the proportion of white to use on the color top, and

whatever part of the square is cut off to the left represents the proportion of black.

Thus, if we wish a value degree 5/8ths of the value distance between black and white, we take the point 5/8ths the way down the diagonal from white to black, draw lines to the top and right hand side of the square, and we discover to the right of these lines is 25/64ths of the square, to the left 39/64ths. Hence, to obtain a degree of value 5/8ths as light as black in the range black to white, we mix 25/64ths of white with 39/64ths of black on the color top.

It is evident that by following this rule any degree of value desired can be obtained. But it is simpler to use the algebraic formula that produces the same results.

Let x = the degree of value.
Let y = the proportion of *white* to use on the color top to obtain value x.
Let z = the proportion of *black* to use on the color top to obtain value x.

Then the formula is merely this:

$$y = x^2$$
$$z = 1 - x^2$$

For instance, suppose we wish to know the proportions of black and white to mix on the color top to obtain a

degree of value 1/4th higher than black in the range black to white. The degree of value, then, is 1/4th. We apply the formula:

$$y = x^2 = (1/4)^2 = 1/16$$
$$z = 1 - x^2 = 16/16 - 1/16 = 15/16$$

Compare this with the results obtained above by the geometrical method. Or, again, if our degree of value is 5/8ths, then

$$y = x^2 = (5/8)^2 = 25/64$$
$$z = 1 - x^2 = 64/64 - 25/64 = 39/64$$

Compare this also with the results obtained above by the geometrical method. This formula, as well as the rule above, will solve for any degree of value desired.

The Roman numerals used in the diagram are the numerals employed in Cutler's scale for the degrees of value designated. Values I, II, and III, however, are the only ones spoken of in the body of the book, and are the only ones represented in Cutler's standard scale.

Appendix 2

The following are two tables compiled by Rood and summarizing the results he obtained in experiments lowering colors to their shadows and raising them to their highlights. They may be found on pages 186 and 197 of his Text-book of Color (D. Appleton & Co., N. Y. and London, 1913). The artist will find them worthy of considerable study.

TABLE I

Name of color	*Effect of reducing its luminosity*
Fundamental red (carmine and vermilion)	Not changed, or made *slightly* purplish
Vermilion	More red, less orange-red
Red lead	More red, less orange-red
Orange	Brown
Chrome yellow or gamboge	Olive green
Greenish yellow	More greenish
Yellowish green	More pure green
Fundamental green	Not changed, or made *slightly* more bluish
Emerald green	More green, less blue-green
Blue-green	More green, less bluish
Cyan blue	More greenish
Prussian blue	Dark gray-blue (not changed)
Cobalt blue	Dark gray-blue (not changed)
Ultramarine blue (artificial)	More violet, less blue
Violet	Dark violet
Purple	More violet, less red
Carmine	Not much changed

TABLE II

Name of color	*Effect of adding white light*
Vermilion	More purplish
Orange	More red
Chrome yellow	More orange-yellow
Pure yellow	More orange-yellow
Greenish yellow	Paler (unchanged)
Green	More blue-green
Emerald green	More blue-green
Cyan blue	More bluish
Cobalt blue	A little more violet
Ultramarine (artificial)	More violet
Violet	Unchanged
Purple	Less red, more violet